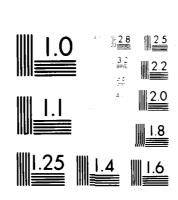
ARINC RESEARCH CORP ANNAPOLIS MD F/6 17/7
COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)
SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-37A8
1326-01-15-2529 DOT/FAA/RD-01/61 NL AD-A112 957 UNCLASSIFIED 1 or 4 291.



MICROCOPY RESOLUTION TEST CHART NATIONAL NUMBER OF STANJANG SHOWS A

1. 1. July 1.

(14)

DOT/FAA/RD-81/61

Office of Systems Engineering Management and Systems Research and Development Service Washington, D.C. 20590

Cost Analysis of the Discrete Address Beacon System for the Low-Performance General Aviation Aircraft Community

- S. Kowalski
- K. Peter
- A. Schust
- D. Swann
- P. Young

September 1981

Final Report

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.



US Department of Transportation
Federal Aviation Administration

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog	No.
DOT/FAA/RD-81/61	47 4 2 2 3 3		
4. Title and Subtitle		5. Report Date	
Cost Analysis of the Disc	rete Address Beacon System	September 198	1
for the Low-Performance Ge		6. Performing Organizati	
Community			
		8. Performing Organizati	on Report No.
 Author's) Kowalski, K. Peter, A. 	Schust, D. Swann, P. Young	1326-01-15-25	29
9. Performing Organization Name and Address ARING Research Corporation		10. Work Unit No. (TRAI	S)
a Subsidiary of Aeronautic		11. Contract or Grant No	
2551 Riva Road	1	DOT-FA76WA-3	799
Annapolis, Maryland 2140	1	13. Type of Report and P	
12. Sponsoring Agency Name and Address		, pe or weport and r	arida Caverea
U.S. Department of Transpo		ETHAL DENODE	
Federal Aviation Administr		FINAL REPORT	
		14 Sangarina Assan C	ada
December of Participation	ring Management and Systems	ARD-200	.004
Research and Development S 15. Supplementary Notes	Service, Wash., D.C. 20591		
Address Beacon System (DAI low-performance general as	the results of cost analysi SS) configurations that may viation aircraft community. cloped by ARINC Research Cor	be implemented to The DABS design	for the ns considered
17. Key Words	18. Distribution States	ient	
DABS	This docume	nt is available	to the public
Costs	through the	National Techni	cal Informa-
		e, Springfield,	
	22161.	-, shramatrerd,	
	22101.		
		T 31 W. / A.	I 20 B.I.
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	364	

	j	4.5	*11		333		**		! h	, ž		•		
: Messure	Į	11	31 1				111					Table of the same	9 002 001	90 00
vaions from Mosai	Market by LEBSTN	3:	223	ANEA	2222	MASS (weight)	27	VOLUME	8 2 2 3 3	¥ Ç	TEMPERATURE (Oxact)	2 5 E	\$ - 08	\$ 1 S
Approximate Constrains from	Man Yes Kan	eillimeters contractors		i	**************************************	7	Librations Librations Service (1980 hg)	J		Cabic maters Cabic maters	31	Cotons	2 - 0	02-
	j	1 8	5	,	l rI1		•3.		1	ነገ		٥	. 0	100
	HAMBARIN HIMITAN			SAMININ		et 						nteratne		
1.1.1.	1.	' ' 	7	יויןייו			וייין יון	' '' ' 	ין. מיןייין	` `''\ <u>'</u>		'1' '1' 	ןייין ויין	:ucpes
	Į		55.5		3333	2	•\$-		111-		ንን		٠	. 285.
Messures	1					Pocines	tribuposes tribuposes		mittibers milliters mittibers files	!	Cubic meters		Coltus	Tables, see MES Nauc. P.
orginus to Motole Mar	***	LEBGTH	2 83 2	AREA	:532	6.4 MASS (weight)	25.5	VOLUME	- 2 8 6	6. 6 6. 6	3 X	TEMPERATURE (exect)	5/5 (aber subtracting 32)	Menits and mare detailed D Catalog No. C13:10:28
Appreciants Consistent to	- in the last	ļ	isti	ļ						iii	cabic tests	1689	Townson to the same of the sam	*) or a 2.56 reasole). For upber event conventionme and mare detailed tables, see 1465 Max. Publ. 236, come of Respire and Messures. Price 5.25; SD Caralog No. C13.10.286.
	j		1431		ንንንን		**		:22.	1	ኄኄ		٠	All a m t.

ACKNOWLEDGMENT

Throughout this study, ARINC Research Corporation received enthusiastic and invaluable support from the engineering and management staffs of the Federal Aviation Administration, Bendix Avionics, King Radio, and NARCO Avionics. Special acknowledgment is made to R. Jones, E. Lucier, and J. Scardina of the FAA and to D. Bowers, formerly of the FAA.

DTIC COPY INSPLCTED 3 NTIC MINE TO STATE OF THE STATE

SUMMARY

This study has developed costs for various Discrete Address Beacon System (DABS) transponder configurations using both discrete and LSI components to assess the cost impact of varying levels of sophistication in a DABS transponder designed for the low-performance general aviation community (single-engine and light twin-engine aircraft). The cost of encoding altimeters was not included in transponder configuration costs. ARINC Research Corporation performed this work under Contract DOT-FA76WA-3788 for the Federal Aviation Administration.

Costs were developed for nine levels of sophistication in the DABS transponder ranging from basic surveillance to a version with Comm A, B, and C and ATARS. ARINC Research Corporation based all designs of transponder configurations on the DABS Draft National Standard of February 1980 with updates where practicable and technical details may not conform to the final DABS National Standard. The ATARS portion of the design is based on FAA SRDS Technical Letter Report No. RD-80-11-LR of April 1980 and the Revised Draft ATARS National Aviation Standard of December 17, 1980. Costs were also developed for a commercially available Air Traffic Control Radar Beacon System (ATCRBS) as a method to verify the cost model.

We used the cost and reliability data derived from our DABS designs to develop the individual aircraft costs and the combined user-community costs of DABS implementation. Calculations of the transponder costs were based on the accounting method of cost estimating. The production cost data were developed through detailed analysis of the methods of several leading avionics manufacturers producing either high- or low-performance aircraft equipment. Total system costs were evaluated with the aid of an economic analysis model.

Tables S-1 through S-3 summarize the DABS cost analysis. Table S-1 identifies the costs of the various DABS configurations in constant 1980 dollars. The values shown are the expected selling price of each configuration, including appropriate markups for distribution. Table S-2 presents the cost per aircraft, also in constant 1980 dollars. Distribution costs have also been included in the data presented. The unit acquisition cost shown in Table S-2 is different from the acquisition cost illustrated in Table S-1 because the life-cycle-cost model allows for the normal distributor discount offered when the distributor installs the avionics in the aircraft. Table S-3 summarizes the total expenditure required to implement

Table S-1. ACQUISITION COST OF TRANSPONDERS (IN CONSTANT 1980 DOLLARS) Components Transponder Configuration Discrete LSI **ATCRBS** 718 Basic Surveillance DABS 1,614 1,239 Basic DABS with Antenna Diversity 2,054 1,679 Basic DABS with 21.5 dBW Antenna 1,617 1,242 DABS with Comm A and B 1,663 1,293 DABS with Comm A and B and ATARS 2,093 1,592 DABS with Comm A and B, ATARS, and BCAS Interface 2,167 1,592 DABS with Comm A, B, and C 1,830 1,413 DABS with Comm A, B, and C and ATARS 2,261 1,719 DABS with Comm A, F, C, and D 2,227 1,781

the airborne portion of DABS. Table S-3 costs are presented in two ways: in constant 1980 dollars and with a 10 percent discount rate in accordance with OMB Circular A-94.

Since each transponder configuration is unique, requiring a design that optimizes the data processing for that configuration, the difference between any set of costs in Table S-1 should not be considered as the expected cost of adding the additional capability. For example, the cost of adding the ATARS capability to an existing DABS transponder with Comm A and B capability cannot be considered as being only \$430, the difference in cost between the two versions. Rather, the cost of the DABS with ATARS can be expected to be \$2,093 if designed originally into the system, and the cost of DABS without ATARS would be only \$1,663. Development costs for LSI technology are not included in the tables; therefore, the cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. Depending on the configuration, amortization cost would add approximately \$114 to \$143 to the list price of a transponder during the first two years.

Table S-2 shows that the cost of any DABS configuration is mainly influenced by the acquisition cost of the transponder. The installation cost is the same for any configuration and the recurring logistic costs are similar. (Antenna diversity and Comm A, B, C, and D have higher recurring logistic costs than the other configurations.)

Table S-3 illustrates the variance in total life-cycle costs between transponder configurations. The cost variance between configurations may

Retrofit Discrete 264 264 264 264 264 264 264 264 264 264	Ret	New New 1,92 1,92 1,95 1,95 1,95 1,95 2,03	Eirst Year of Ownership ew Retrofit 516 1,585 927 2,029 518 1,587 556 1,625 899 1,968 959 2,028 689 1,758	Life-Cy New 1,768 2,347 1,770 1,822 2,151 2,225	Life-Cycle Cost New Retrofit 1,768 1,837 2,347 2,449 1,770 1,837 1,822 1,891 2,151 2,220 2,225 2,294 1,941 2,010
Lenna Power 1,303 195 264 1,655 242 344 1,305 195 264 1,745 195 264 195 264 195 264 195 264 195 264 195 264 1,745 195 264 195 264 1,745 195 264 1,793 195 264 1,355 242 344 1,355 242 344 1,355 242 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,285 195 264	Discrete 264 344 264 264 264 264 264 264 264			New 1,768 2,347 1,770 1,822 2,151 2,225	Retrofit 1,837 2,449 1,837 1,891 2,220 2,220 2,294
Lenna Power 1,303 195 264 1,686 195 264 344 1,305 195 264 344 1,342 195 264 195 264 1,745 195 264 195 264 1,745 195 264 195 264 1,820 195 264 1,820 195 264 1,793 195 264 1,355 242 344 1,355 242 344 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264 1,005 195 264	Discrete 264 344 264 264 264 264 264 264			1,768 2,347 1,770 1,822 2,151 2,225	1,837 2,449 1,837 1,891 2,220 2,294
Lenna Power 1,303 195 264 Lenna Power 1,305 195 242 344 B and ATARS 1,686 195 264 B, ATARS, 1,745 195 264 Interface 1,476 195 264 and C and 1,820 195 264 C, and D 1,793 195 264 LEST LEST LEST LANG B and ATARS 1,285 195 264 B and ATARS 1,285 195 264	264 344 264 264 264 264 264 264			1,768 2,347 1,770 1,822 2,151 2,225	1,837 2,449 1,837 1,891 2,220 2,294
Lenna Power 1,655 242 344 Lenna Power 1,305 195 264 B and ATARS 1,686 195 264 B, ATARS, 1,745 195 264 Interface 1,476 195 264 and C and 1,820 195 264 Lorina Power 1,003 195 264 Lenna Power 1,005 195 264 B and ATARS 1,285 195 264	344 264 264 264 264 264 264			2,347 1,770 1,822 2,151 2,225	2,449 1,837 1,891 2,220 2,294 2,010
tenna Power 1,305 195 264 1,342 195 264 8 and ATARS 1,686 195 264 B, ATARS, 1,745 195 264 Interface 1,476 195 264 and C and 1,820 195 264 C, and D 1,793 195 264 tenna Power 1,005 195 264 B and ATARS 1,285 195 264	264 264 264 264 264 264			1,770	1,837 1,891 2,220 2,294 2,010
B and ATARS 1,686 195 264 B, ATARS, 1,686 195 264 Interface 1,745 195 264 Interface 1,476 195 264 and C and 1,820 195 264 C, and D 1,793 195 264 Eenna Power 1,005 195 264 B and ATARS 1,285 195 264	264 264 264 264 264			1,822 2,151 2,225	1,891 2,220 2,294 2,010
B and ATARS 1,686 195 264 B, ATARS, 1,745 195 264 Interface 1,476 195 264 and C and 1,820 195 264 C, and D 1,793 195 264 Eenna Power 1,003 195 264 B and ATARS 1,285 195 264	264 264 264 264			2,151	2,220 2,294 2,010
B, ATARS, 1,745 195 264 Interface 1,476 195 264 and C 1,820 195 264 c, and D 1,793 195 264 c, and D 1,793 195 264 LEST 1,003 195 264 tenna Power 1,005 195 264 B 1,045 195 264 B and ATARS 1,285 195 264	264 264 264 264	<u> </u>		2,225	2,294
Interface 1,476 195 264 and C and D 1,793 195 264 264 2, and D 1,793 195 264	264 264 264			1,941	2,010
and C	264 264 264			1.941	2,010
and C and 1,820 195 264 C, and D 1,793 195 264 LSI LESI LHO03 195 264 LENNA Power 1,005 195 264 B and ATARS 1,285 195 264	264			- 12/21	•
Education (1,793) 195 264 LISI 1,003 195 264 1,355 242 344 Enna Power 1,005 195 264 B and ATARS 1,285 195 264	264		_	2,300	2,369
E, and D 1,793 195 264 1,003 195 264 1,355 242 344 1,005 195 264 B and ATARS 1,285 195 264	264				
LSI 1,003 195 264 1,355 242 344 1,005 195 264 8 and ATARS 1,285 195 264		2,010	2,079	2,318	2,387
1,003 195 1,355 242 1,005 195 8 and ATARS 1,285 195	LSI Version				i
1,355 242 tenna Power 1,005 195 B and ATARS 1,285 195		1,215	5 1,284	1,453	1,522
tenna Power 1,005 195 8 and ATARS 1,285 195	344		2,017	1,727	2,119
B and ATARS 1,285 195	264		1,286	1,455	1,524
B and ATARS 1,285 195	264			1,495	1,564
		_	٦,	1,735	1,804
Comm A and B, ATARS, 1,285 195 264	564	1,497	1,566	1,735	1,804
ace	-				
and C 1,142 195	264			1,577	1,646
B, and C and 1,386		1,598	3 1,667	1,836	1,905
				,	•
Comm A, B, C, and D 1,436 195 264		1,652	2 1,721	1,946	2,015

Table S-3. SUMMARY OF LIFE-CYCLE COSTS FOR DABS TRANSPONDERS FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY Constant Discounted Transponder Configuration 1980 Dollars 1980 Dollars (In Millions) (In Millions) Discrete Version Basic Surveillance DABS 684.3 195.8 Basic DABS with Antenna Diversity 891.3 253.7 Basic DABS with 21.5 dBW at Antenna 685.2 196.1 DABS with Comm A and B 700.3 200.4 DABS with Comm A and B and ATARS 838.7 240.9 DABS with Comm A and B, ATARS, and BCAS 862.9 247.9 Interface 750.9 DABS with Comm A, B, and C 215.4 DABS with Comm A, B, and C and ATARS 893.5 256.8 256.9 DABS with Comm A, B, C, and D 896.6 LSI Version Basic Surveillance DABS 558.4 159.3 Basic DABS with Antenna Diversity 765.1 217.2 Basic DABS with 21.5 dBW at Antenna 567.1 159.6 DABS with Comm A and B 575.9 164.4 DABS with Comm A and B and ATARS 670.4 192.1 DABS with Comm A and B, ATARS, and 670.4 192.1 BCAS Interface DABS with Comm A, B, and C 610.9 174.9 DABS with Comm A, B, and C and ATARS 715.4 205.0 DABS with Comm A, B, C, and D 746.7 213.5

be traced directly to the acquisition cost of the transponders. Adding ATARS to a discrete component configuration results in an increase in life-cycle cost of approximately 19 percent over a similar configuration without ATARS. In LSI configurations there is an increase in cost of approximately 16 percent with the addition of ATARS. The most costly configuration is DABS with Comm A, B, C, and D.

CONTENTS

		Page
ACKNOWLED	GMENT	iii
SUMMARY .		v
CHAPTER O	NE: INTRODUCTION	1-1
1.1	Background	1-1
1.2	Project Overview	1-1
1.3	Organization of the Report	1-2
CHAPTER T	WO: APPROACH	2-1
2.1	System Concept	2-2
2.2	Required Avionic Equipments	2-3
2.3	Retail Cost Method	2-3
2.4	Development of Economic Analysis Model	
2.5	Common Data Elements	2-4
2.6	Approach Summary	2-5
CHAPTER T		
	DEVELOPMENT	3-1
3.1	Transponder Configurations	3-1
	3.1.1 Baseline DABS	3-2
	3.1.2 Baseline DABS with Antenna Diversity	3-5
	3.1.3 Baseline DABS with 21.5 dBW at Antenna	3-6
	3.1.4 DABS with Comm A and Comm B	3-6
	3.1.5 DABS with Comm A and B and ATARS	3-7
	3.1.6 DABS with Comm A and B, ATARS, and BCAS Interface .	3-9
	3.1.7 DABS with Comm A and B and Uplink ELM (Comm C)	3-9
	3.1.8 DABS with Comm A and B, ATARS, and Comm C	
	3.1.9 DABS with Comm A and B and Comm C and D	
	3.1.10 Large Scale Integration (LSI)	
3.2	Development of Transponder Costs	3-11
	3.2.1 Baseline DABS	3~12
	3.2.2 Baseline DABS with Antenna Diversity	3-15
	3.2.3 Baseline DABS with 21.5 dBW at Antenna	
	3.2.4 DABS with Comm A and Comm B	
	3.2.5 DABS with Comm A and B and ATARS	
	3.2.6 DABS with Comm A and B. ATARS, and BCAS Interface .	

CONTENTS (continued)

	<u> </u>	age
3. 3.	.2.7 DABS with Comm A and B and Uplink ELM (Comm C)	3-22 3-33
3.3 Tr 3.4 Su	ransponder Reliability	}-34 }-35
CHAPTER FOUR	R: LIFE-CYCLE-COST MODEL COMMON PARAMETERS	4-1
4.2 Ai 4.3 Ir 4.4 Ai 4.5 Ma	ost of DABS Electronics Components	4-1 4-1 4-3 4-4
	.5.2 Off-Aircraft Maintenance	4-5
5.2 Ad 5.3 Re 5.	E: INDIVIDUAL AND FLEET COSTS FOR DABS IMPLEMENTATION	5-1 5-1 5-1 5-1 5-2 5-3
CHAPTER SIX:	: SENSITIVITY OF THE DABS COST ANALYSES TO PARAMETER VARIATIONS AND ALTERNATIVE ASSUMPTIONS	6-1
6.2 Se 6.3 Th	ensitivity of Life-Cycle Cost to MTBF Variations ensitivity of Life-Cycle Cost to LSI and Material Cost he Effect of Including Amortization of Manufacturers' SI Development Costs	6-1 6-4 6-6
CHAPTER SEVE	EN: RESULTS OF EVALUATIONS	7-1
7.2 Li 7.3 Di 7.4 Re	ost Data of Transponder Configurations Evaluated ife-Cycle Cost for the User Community iscussion of Sensitivity Analysis elation of the DABS Cost Analysis to the Implementation	7-1 7-2 7-5

CONTENTS (continued)

		Page
APPENDIX A:	SYSTEM PARTS LIST AND COST-DEVELOPMENT DATA SHEETS	A-1
APPENDIX B:	MATHEMATICAL FORMULATION OF THE COST MODEL	B-1
APPENDIX C:	LIFE-CYCLE-COST MODEL PROGRAM	C-1
APPENDIX D:	LIFE-CYCLE-COST MODEL PARAMETER SUMMARY	D-1
ADDENDIY F.	DISCOPTE ANDDESS BEACON SVETEM TRANSDONDED DESIGNS	E-1

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The Federal Aviation Administration (FAA) has sponsored the development of the Discrete Address Beacon System (DABS) as a near-future replacement of the Air Traffic Control Radar Beacon System (ATCRBS) surveillance system. DABS, by design, will be capable of providing surveillance, communications, and, when combined with the Automatic Traffic Advisory and Resolution Service (ATARS), collision avoidance information to aircraft within areas of coverage. DABS avionics have been specified for the full-capability user, but their capability and cost have not been specified for the low-performance general aviation aircraft users. Such specifications are vital because the largest user of avionics is the general aviation community, primarily the single-engine and light twin-engine low-performance aircraft.

The Systems Research and Development Service (SRDS) in conjunction with the Office of Systems Engineering Management (OSEM) of the FAA tasked ARINC Research Corporation, under Contract DOT-FA76WA-3788, to develop a family of designs to be used for cost analysis of DABS transponders for low-performance general aviation aircraft. The cost of encoding altimeters was not included in transponder configuration costs. The designs were to include the basic surveillance capability, communications capability, and ATARS capability. Using those designs ARINC Research Corporation was to develop the engineering, manufacturing, distribution, and support costs for the DABS transponders to estimate a retail selling price. This projected retail price was to be used to calculate the cost of ownership of the transponder over its life cycle.

1.2 PROJECT OVERVIEW

The overall objective of this project was to identify the cost of manufacturing the DABS transponders to be used by low-performance general aviation aircraft. For comparison, the life-cycle costs (LCC) of the DABS transponders were to be evaluated for a typical period of ownership. To meet this objective, it was necessary to design a DABS transponder to provide a basis for subsequent cost analysis. Since it was the intent of the FAA to achieve a retail cost appropriate for present low-performance general aviation aircraft avionics, the analysis was structured to identify various levels of sophistication with their associated costs to the users.

ARINC Research Corporation developed the designs and costs for nine levels of sophistication in the DABS transponder. These designs were developed with both discrete and LSI logic, and costs were estimated by traditional accounting methods. The total LCC was calculated by use of a modification of the economic analysis model (EAM) we developed under Contract DOT FA74WA-3506. This report presents the results of the analysis and the constraints applied to ensure uniformity in the development of the transponder costs. The study results are presented in 1980 dollars, consistent with the technology and available data on which the estimates were made.

1.3 ORGANIZATION OF THE REPORT

The seven chapters of this report address the transponder designs and the techniques used for estimating the unit and life-cycle costs of the designs and presents the results of the analysis.

Chapter Two describes the overall approach to developing the economic evaluations and the modeling method used to obtain the desired unit and life-cycle costs.

Chapter Three describes the development of the cost, reliability, and design data for the different complexity levels of the DABS transponders for both the discrete and LSI designs.

Chapter Four addresses the LCC model used for this study.

Chapters Five and Six address the results of the LCC study and a sensitivity analysis of them.

Chapter Seven summarizes the results of the analysis and presents conclusions derived from the analysis.

Appendix A provides the detailed cost sheets associated with the analysis, Appendix B describes the LCC model, Appendix C presents the LCC model, Appendix D addresses the common parameters used in the LCC, and Appendix E contains the DABS design sheets.

CHAPTER TWO

APPROACH

The costs of the various DABS configurations were developed in a manner that would allow comparison between the configurations in the costs of acquisition, installation, and logistic support. Identical scenarios were employed (e.g., time of implementation and aircraft statistics) to assure that cost benefits associated with the different configurations would be readily comparable.

The development of detailed and accurate cost analyses of avionics equipments that currently exist only in prototype form can pose a number of formidable problems, including the following:

- Conversion of Engineering Requirements to Production Configuration of Equipment. The system concepts are in various stages of evaluation and employ existing technology levels. Evaluation criteria must be used that take into account these limitations to ensure that the study evaluates production-quality equipments.
- Anticipation of the Needs of the Aviation Community. The costs of any new equipment are controlled by the demand for the product. The demand for DABS transponders had to be identified over a given time frame to permit estimation of production quantities and to justify development of the microelectronics necessary for cost-effective manufacture of these transponders. Therefore, it has been necessary in the study to limit the implementation schedule to a realistic time span.
- Development of the Necessary Additional Data Required for a Comprehensive Cost Analysis. Although the development of data (such as aircraft fleet sizes) that apply equally to any DABS configuration is of the lowest criticality in a comparative cost evaluation, it is extremely important to the accurate development of total implementation costs.

The general approach followed by ARINC Research Corporation in resolving these problems and obtaining the economic evaluation of the DABS configurations is illustrated in Figure 2-1.

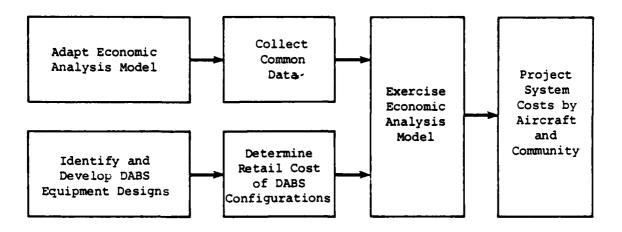


Figure 2-1. DABS ECONOMIC ANALYSIS APPROACH

An existing ARINC Research economic analysis model was adapted to evaluate the DABS implementation scenario. Parallel data-collection efforts were then initiated to obtain the common and system-peculiar input data needed to exercise the model. The common data, such as aircraft populations, installation costs, and maintenance scenarios, were developed or obtained from existing FAA documents. The model was also exercised for key parameter variation cases in order to investigate the sensitivity of the results obtained to the input data and to the assumptions employed in the analysis. The outputs of each model exercise were the resultant acquisition, installation, support, and total costs, by aircraft and for the total user-community, for each year and cumulatively for the 15 years from 1987 through 2001.

The remainder of this chapter gives details of how this task was approached.

2.1 SYSTEM CONCEPT

The Discrete Address Beacon System is a cooperative surveillance and communications system for air traffic control. It employs ground-based interrogators and airborne transponders. Data-link communications are integrated with surveillance interrogations and replies. DABS has been designed as an evolutionary replacement for the current Air Traffic Control Radar Beacon System to provide the surveillance and communications capability required for air traffic control in the projected 1995 traffic environment. DABS uses the same frequencies for interrogation and replies as ATCRBS. The DABS transponder must reply to both ATCRBS and DABS interrogations, and it provides an interface with a variety of data-link message display and input devices.

The communications capability provides an air-to-air data link for the Beacon Collision Avoidance System (BCAS) and the ability to receive and respond to the Automatic Traffic Advisory and Resolution Service (ATARS). Chapter Three of this study describes the development of the DABS transponder configurations and the costs and reliabilities associated with the equipments.

2.2 REQUIRED AVIONIC EQUIPMENTS

This study was limited to an evaluation of the cost and reliability of the airborne equipments required to provide the DABS function for the low-performance general aviation aircraft. The equipments consisted of several DABS transponder configurations and miscellaneous hardware required for their proper installation and operation. The transponders have the operational characteristics defined by the Draft DABS National Standard of February 1980 and have been updated where feasible to reflect changes in later versions of that standard. The ATARS portion of the design is based on FAA SRDS Technical Letter Report No. RD-80-11-LR of April 1980. The revised ATARS Draft National Aviation Standard of December 17, 1980, also was considered in relation to the ATARS design. Equipment design allows for expected technological advances in the near future and uses proven existing transponder concepts where they are economically advantageous.

2.3 RETAIL COST METHOD

The cost evaluation technique chosen was the industry standard accounting method of calculating production costs on the basis of estimates of the numbers and types of piece parts. The method requires detailed bills of material and associated labor units, schematic diagrams, mechanical and electronic module layouts, and an estimate of the total quantity of units to be manufactured. Material costs were based on original equipment manufacturer (OEM) price lists for quantities of 1,000 or greater, and allowances were made for discounts available for large parts procurements common to equipment manufacturers. Finally, the accounting structures of potential manufacturers had to be known to allow for labor, overhead charges, quality-control costs, general and administrative expenses, and the usual profits earned in the avionics industry.

The data necessary for the preparation of the cost-estimating worksheets are usually taken directly from engineering bills of material. component part numbers are identified and quantities entered on the worksheets. Procurement costs of the components are obtained either from OEM price lists or, where the component is unique or has a high cost, through direct quotes provided by distributors. Labor associated with fabrication or assembly of components is estimated in hours per 1,000 units for a mass production assembly line. Historical data maintained by most manufacturers provide the average labor estimates for both manual and automatic insertion processes. These data provide the average amount of labor associated with assembly of components configured in a module (e.g., printed circuit card) or subassembly. The total labor hours are evaluated to compare the complexity of the assembly with historical data. If the module is complex (that is, it has a high component density or requires printed circuit boards with multiple layers), a compensating factor is applied to the labor estimate. The resultant material costs and labor estimates provide the data necessary for cost estimates.

The worksheets used in developing total equipment costs are structured to provide cost information on individual modules (or subassemblies) and total avionics units. Costs are displayed in that fashion to provide information that is useful in evaluating life-cycle costs where module stockage and associated costs are necessary for determining the recurring and non-recurring logistics costs. Total avionics unit costs include unit assembly, test, and integration costs.

Developed costs include the expense of materials, material handling charges, labor at either known or estimated hourly rates, average overhead obtained from a sampling of avionics manufacturers, and factory inspection costs during production. The addition of general and administrative (G&A) costs, together with a reasonable profit, provides the OEM or selling price of the unit. This is the cost distributors handling the product or large fleet owners buying avionics at quantity prices expect to pay. Private aircraft owners usually purchase avionics from distributors and pay an additional distributor handling markup of 100 percent.

The output data sheets are also structured to permit easy reevaluation of the expected costs of avionics by substituting different labor, overhead, G&A, profit, and markup rates if there is justification or if a manufacturer prefers to use the exact factory rates rather than the average of the industry.

2.4 DEVELOPMENT OF ECONOMIC ANALYSIS MODEL

The specific means of assessing the projected costs associated with each of the DABS configurations was through the development and exercise of a computer-based cost model. This model determined the annual and cumulative costs associated with each DABS system type and tabulated these costs by aircraft and for the total user community. The model was developed by tailoring existing ARINC Research cost models to the specific characteristics of the DABS concepts and the low-performance general aviation aircraft community.

The input data to the EAM consist of two types: data that are unique to the particular DABS configuration being evaluated and data that are common to all of the configurations being evaluated. The specific requirements for each type of data were defined concurrently with the development of the model, and data were collected.

After the data had been collected, the model was exercised for each system concept in the user community. In addition, the EAM was exercised to determine the sensitivity of the results obtained to variations in key parameters (e.g., MTBF).

2.5 COMMON DATA ELEMENTS

The data common to all of the DABS concepts consist of four basic types: (1) installation costs, (2) aircraft fleet size projections, (3) aircraft equipment configurations, and (4) user operation and maintenance

parameters (e.g., average flying hours per month, labor rates, pipeline times).

The cost of installing transponders in new aircraft was assumed to be 60 percent of retrofit costs. The installation costs for the general aviation community were therefore determined by updating general aviation retrofit costs developed for previous ARINC Research studies.

Aircraft fleet size projections for the general aviation user community were obtained by analyzing data from various FAA reports and projections and linearly extrapolating the data through 2001.

Estimates of the common data elements peculiar to the general aviation community were developed from information ARINC Research gained in earlier similar studies.

2.6 APPROACH SUMMARY

The preceding sections have provided an overview of the technical approach used in the study, outlined the capabilities of the EAM, described its use, and identified the general types of data to be used in the evaluation. The succeeding chapters of this report describe in detail the DABS configurations, the retail costs, the characteristics of the EAM, and the specific results of the study.

CHAPTER THREE

TRANSPONDER CONFIGURATIONS, COST, AND RELIABILITY DEVELOPMENT

The introduction of the DABS transponder to the low-performance general aviation aircraft population will result in user investment costs to attain a degree of performance necessary for the safe and efficient use of the National Air Space (NAS). DABS is capable of providing services ranging from surveillance only to complete communications using the integral data link; the level of capability desired by the users will depend on the costs associated with the different levels. This chapter identifies the capabilities recommended by the FAA and evaluates the acquisition costs associated with each design of the DABS transponder.

3.1 TRANSPONDER CONFIGURATIONS

The DABS transponder is intended to replace the Air Traffic Control Radar Beacon System transponder in providing the secondary surveillance functions of position and altitude reporting. In addition, when the 112bit capability of the data link is included in the transponder, the system can support not only general purpose data link but also aircraft separation and collision avoidance advisories as part of the ATARS implementation. Since the transponder will be operating in an environment that includes BCAS equipment, provisions have been made in the DABS National Standard for exchange of information between DABS and BCAS equipment on status of displays and complimentary maneuvers. Finally, the extended length message (ELM) capability of the DABS concept is introduced to identify the potential cost of a transponder that is capable of supporting the widest range of DABS data link services. Since each of the capabilities requires specialized data processing with the airborne transponder, separate designs that provide the desired capabilities have been developed during the course of this study. This has resulted in the nine levels of DABS transponder configurations listed below and discussed in this section:

- · Baseline DABS
- · Baseline DABS with antenna diversity
- · Baseline DABS with 21.5 dBw power output at antenna
- · DABS with Comm A and B
- . DABS with Comm A and B and ATARS
- · DABS with Comm A and B, ATARS, and BCAS interface

- DABS with Comm A and B and uplink ELM (Comm C)
- DABS with Comm A and B, ATARS, and uplink ELM (Comm C)
- DABS with Comm A and B, and uplink/downlink ELM (Comm C and D)

Figure 3-1 presents a functional description of the entire DABS transponder. The diagram displays in detail the interconnection of various modules of the baseline system. Each of the various system configurations resulting from adding complexity is indicated by a single functional block (e.g., ATARS) and connected to the appropriate circuitry in the baseline transponder. The intent of Figure 3-1 is to show the interrelationships of the major modules of the DABS transponder; Appendix E contains a detailed discussion of many of these modules. The various DABS configurations are discussed in the following sections.

3.1.1 Baseline DABS

The baseline DABS transponder is designed to meet the surveillance requirements identified in the DABS National Standard responding to the conventional ATCRBS Mode 3A and C interrogations and the 56-bit P6-pulse of the discrete address interrogations. The design conforms to the DABS uplink field format Numbers 0, 2, 4, 5, and 11 as defined in the standard. Special provisions for site lockout, protocol, reply rate limiting, etc., associated with the use of a 56-bit data field of DABS have been included in the decode and encode functions of the logic design.

The transponder has been regmented into modules, or subassemblies; its configuration could be as shown in Figure 3-2. The front end consists of a conventional duplexer and low-pass filter used in modern ATCRBS transponders. The IF amplifier module includes the local oscillator, an expanded logarithmic amplifier, pulse width discriminator, and ditch-digger circuitry. Changes from a conventional logarithmic amplifier include additional intermediate stages to improve discrimination in signal strength and modified ditch-digger circuitry to permit 6 dB discrimination of the P4 pulse.

The differential phase shift keying (DPSK) demodulator utilizes phase-locked loop (PLL) circuitry operating at the 10 MHz IF frequency. Controlled gating is provided from the decoding timing circuit to inhibit false phase reversal from the leading edge of the P6 pulse. The PLL technique was chosen because of cost considerations. Available PLL circuits will operate in the 60 mHz region although the manufacturers of the PLL chips cannot now guarantee settling times required for lock-on to a phase reversal in less than fifteen cycles (settling times up to twenty cycles are typical). The lack of suitable PLL chips for this application stems from a lack of requirements for development rather than inadequate technology. When the logic manufacturers recognize a need, they will develop the necessary hardware.

Output power is developed from a conventional cavity oscillator tube used in modern ATCRBS transponders. The choice of a tube rather than solid-state devices was dictated by cost. Those transponder manufacturers we asked agreed that a transition to solid state would be made when either the

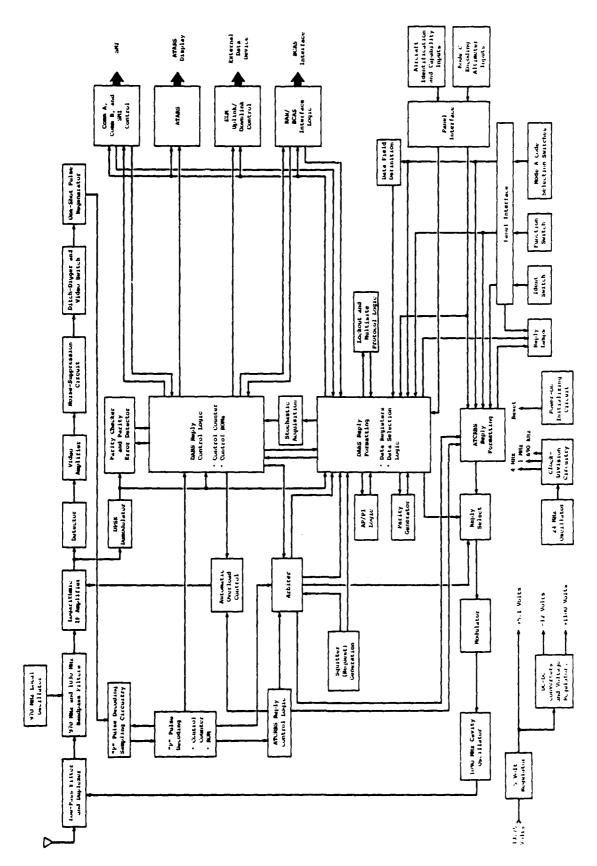
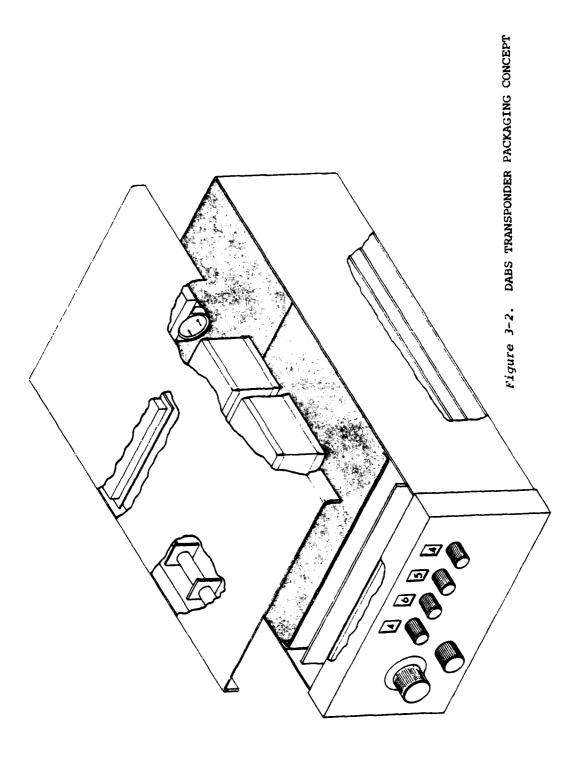


Figure 3-1. DABS FUNCTIONAL DIAGRAM



cost of solid-state amplifiers fell to the comparable cost of the tube configuration, or the cost of the cavity oscillator increased to the present cost of solid state. For the majority of configurations studied the cavity oscillator tube provides the necessary output characteristics for proper operation of the DABS transponder. Power supplies, however, are affected by each configuration. The power supply was designed to provide 141 watts peak power at the antenna and sufficient capacity in the storage capacitors to meet the reply rates specified in the National Standard. However, even though the capacity exists for the transponder to generate up to 2000 replies per second (consistent with maximum ATCRBS reply rate specifications) it is believed that currently available cavity oscillators are incapable of such a high duty cycle and would break down. Normal reply rates specified (e.g., four percent duty cycle average over a 25-millisecond interval) are well within the capability of the cavity oscillator.

Packaging of the transponder is a critical consideration for a manufacturer since it must compete for limited space in the avionics panel of single-engine aircraft. Modern ATCRBS transponders have been miniaturized to occupy a panel space of 6.25 x 1.63 inches. This typically includes one large printed circuit board and additional RF components. The discrete version of the baseline DABS transponder will require two large printed circuit (PC) boards for the decode/encode function, a small modulator/demodulator board, and a power supply PC board, as well as the RF/IF subassemblies. Since the majority of space is occupied by integrated circuit (IC) chips, the boards can be packaged with minimum separation resulting in a transponder that will require a panel space of 6.25 x 3.5 inches and a depth of approximately 11 inches for the most complex design. Normal mode select and code select switches will be accessible on the front panel as well as various indicator lamps to identify the source of interrogation, reply activity, and transponder status.

3.1.2 Baseline DABS with Antenna Diversity

The introduction of the Beacon Collision Avoidance System has generated the possibility of transponder interrogations from angles other than below the aircraft. Since both antenna shielding and multipath effects could cause either failure to reply or erroneously timed replies, a technique for improving reply reliability must be evaluated. The installation of both bottom— and top—mounted antennas connected to independent RF and IF receivers will permit detection of the stronger interrogator signal for processing and reply. The use of a diversity switch at the output of the logarithmic amplifier controlled by signal strength will allow processing of only the desired interrogation.

This DABS transponder configuration is identical to the baseline configuration described in Section 3.1.1 with the following additions to provide diversity operation:

- Two independent receiver sections consisting of a duplexer, lowpass filter, oscillator, and expanded logarithmic amplifier
- Independent video processing

- An analog diversity switch circuitry added to the modulator/demodulator PC board
- An additional modulator controlled by the action of the diversity switch, which selects the same antenna for transmission as for reception
- An additional cavity oscillator tube to provide transponder output power on the chosen antenna

The use of independent receiver stages is conventional for diversity operation since signal strength detection usually occurs at the video stages. However, the dual transmitter concept was chosen after careful review of available RF switches, hybrids, and circulators and the switching times necessary to reply on the selected antenna. When costs of the switching components were compared to the cost of a second modulator and cavity oscillator, the latter configuration proved more economical.

The transponder packaging is not expected to be adversely affected by the addition of the diversity operation and should remain as specified for the baseline case. However, some additional depth may be required.

3.1.3 Baseline DABS with 21.5 dBW at Antenna

The baseline DABS was designed for a nominal output power of 21.5 dBW measured at the terminals of the antenna. This assumed 2 dB cable loss (10 feet of RG-58 cable) between transponder and antenna location. The output power of the cavity oscillator was controlled by the high voltage applied to the tube. At 1100 volts the cavity delivers 225 watts, or exactly 21.5 dBW at the antenna. At maximum operating rating (i.e., 1400 volts) the cavity will provide 325 watts into a characteristic 50-ohm load. If the same 2-dB cable attenuation is considered, the transponder is capable of delivering 23.5 dBW into the antenna. The Draft DABS National Standard distinguishes between aircraft operating limits, requiring the 18.5 dBW minimum for aircraft operating below 15,000 feet and 21.0 dBW minimum for aircraft operating above 15,000 feet. All measurements are made at the antenna. Because of excess power in the baseline DABS, the interest in 21.5 dBW power output is met by operating the cavity oscillator at the typical rated power. A change in the cavity oscillator for higher power is not necessary since the specifications of the Draft National Standard are exceeded.

Since features of the baseline design are identical except for the high-voltage transformer and additional storage capacity in the power supply, the effect of obtaining up to 23.5 dBW at the antenna on transponder design and cost is minimal.

3.1.4 DABS with Comm A and Comm B

The natural expansion of the baseline DABS transponder would affect the data-link capability of the system. The baseline transponder has a limited, highly regimented 56-bit data field to perform surveillance functions. Expansion of the data field to 112 bits provides 56 bits of data for various

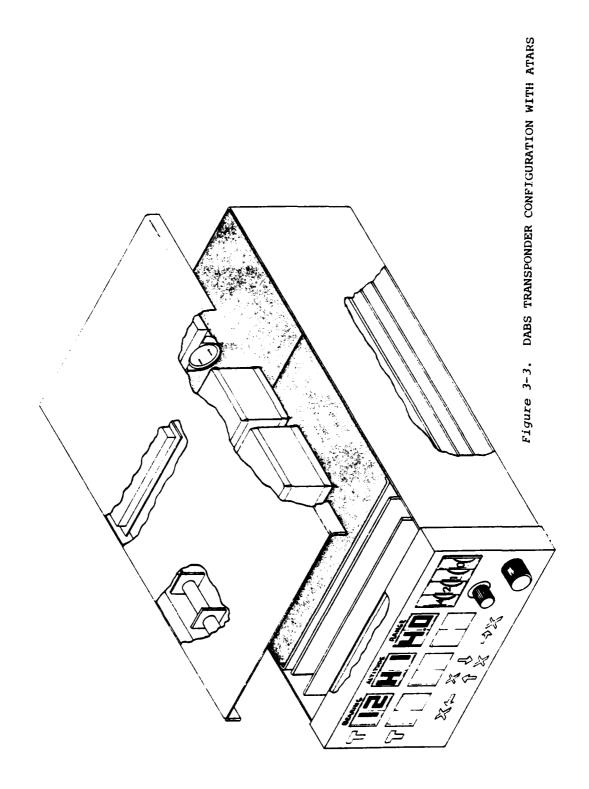
communications functions while performing all the surveillance-associated functions of the baseline design. Although message content and codes for the additional 56 bits are not included in the Draft National Standard, it is expected that they will be used for a wide range of data link services including air traffic control information exchange and ATARS advisories. The expansion to include the 56 bits (Comm A and Comm B capability) affects the encode-decode design of the transponder and the power supply capacity and requires the addition of a real-time standard message interface. All other aspects and performance specifications are the same as for the base-line case described in Section 3.1.1.

Since the transponder with a 112-bit data field capability appears to be the more practical design for early implementation, specific details of design have been provided for review and are included in Appendix E. Major emphasis is placed on the digital processing since the remainder of the transponder virtually duplicates a conventional modern ATCRBS transponder. The logic design is primarily TTL using discrete components readily available from a variety of manufacturers. The discrete component approach was chosen for two reasons: the timing considerations associated with a 4-mbps data rate dictated the use of logic suitable for parallel processing, and the need for discrete design which could identify components for conversion to large scale integration (LSI) configurations. Use of existing microprocessor systems was considered but rejected except for specialized functions because of the relatively slow processing capabilities of modern microprocessors.

3.1.5 DABS with Comm A and B and ATARS

Aircraft equipped with DABS transponders capable of processing 112-bit messages have the potential for receiving traffic advisory information on the relative location of proximate and potentially threatening aircraft and resolution advisories when a near-miss or collision is predicted by the automated ground computer system. In order to provide this capability, certain processing and display functions have been added to the transponder configuration described in Section 3.1.4. Details of logic design associated with ATARS capability are included in Appendix E.

The advisory information presented to the pilot conforms to message protocol for ATARS class 0 service, which was defined in the draft ATARS National Aviation Standard (revised 12-17-80 version). Space constraints on the front panel of the transponder limit information to bearing, altitude, and range of two aircraft with the highest proximity or threat (T) priorities. The bearing information is displayed on two seven-segment LED packages providing 12 o'clock relative information of intruder aircraft. Altitude information is provided as being above (HI), below (LO), or at the same altitude (CO). Range is displayed in tenths of nautical miles up to 9.9 nm. Complementing the alphanumeric displays are a set of arrows and Xs providing advisories for vertical and horizontal maneuvers or restrictive maneuvers. The panel layout, together with code and mode selector switches, is shown in Figure 3-3. The 3.5-inch-high panel can accommodate all the control and display functions if thumb-wheel switches are used for code selection.



The ATARS logic, as proposed, will be packaged on a separate PC board that contains the decoder for advisory information transferred from the DABS decoders after parity check and the display driver logic necessary for illustrating and holding advisory messages. In addition, the PC board would include the resolution advisory register (RAR) for transmission of displayed information to BCAS-equipped interrogators.

3.1.6 DABS with Comm A and B, ATARS, and BCAS Interface

The data link inherent in the DABS concept will permit communications between two BCAS-equipped aircraft, and provide BCAS activity control when the BCAS-equipped aircraft is within the range of a ground-based radar beacon transponder (RBX). The BCAS interface function incorporated in this configuration of the DABS transponder permits air-to-air communications over complementary frequencies of DABS and BCAS when uplink or downlink fields UF, DF=O, or 16 are detected. In addition, RBX transmissions for squitter or reply are received by the DABS receiver and forwarded to the BCAS processors when uplink fields (UF = 6,22) are detected. This interface capability is included in the ATARS functional module with connection between the two avionics equipments through the rear connectors. The design assumes very short cables between the BCAS and DABS units, permitting transfer of digital data without degradation.

3.1.7 DABS with Comm A and B and Uplink ELM (Comm C)

The extended length message format allows up to 16 segments of data to be transmitted over the Comm C data link. Since each segment can be sent in any order chosen by the ground, all segments must be retained in memory within the DABS transponder before being forwarded to an external display device. The addition of the uplink ELM to the transponder requires a microprocessor with peripherals to handle the communications. All other functions are the same as those described in Section 3.1.4. The logic required for Comm C operation will be added to the decoding boards. With discrete logic this will result in a total of three printed circuit boards measuring 6 x 6 inches, which are mounted horizontally in the transponder enclosure. The ELM data will be brought out at the rear connector for processing in other avionics.

3.1.8 DABS with Comm A and B, ATARS, and Comm C

Reintroduction of the ATARS information to the system described in Section 3.1.7 results in the configuration discussed here. All uplink data capabilities of DABS are considered, with required processing being performed within the transponder. Traffic and resolution advisory displays are integrated into the transponder enclosure while Comm C and portions of Comm A information are routed to external processors for display. The package for this configuration is similar to that shown in Figure 3-2, but it requires some additional unit length.

3.1.9 DABS with Comm A and B and Comm C and D

Comm D provides for the downlink transmission of ELM data. Data structure is similar to that for Comm C, requiring up to 16 segments of 112-bit messages. The entire message is stored in the transponder data buffers and transmitted, at ground command, by the number of the segments the ground directs. Provisions exist for repetition of any segment at ground's instructions, and data are not cleared until the system is so instructed by the ground segment. Because of the extended length of Comm D transmissions, the duty cycle on the airborne transmitter is higher than is available from cavity oscillators used in modern ATCRBS equipment. is believed that solid-state amplifiers will be required to provide the temperature control necessary for the higher duty cycles resulting in changes to the modulator, final amplifier, and power supplies of the DABS transponder. The configuration discussed here assumes a power amplifier package rated for 18.5 dBW output at the antenna. A modulator would convert the digital data to a pulsed position input into a preamplifier, which could drive the amplifier package at about 150 watts peak for transmission. Since amplifiers can be designed at resonant frequencies without the need for crystal oscillator control, the unit would operate virtually the same as a cavity oscillator but with the capability for a much greater duty cycle. The power supply would require dc/dc transformation to permit 50 V operation from 14 V aircraft power and extensive storage capacity for the specified transmission of up to 16 consecutive 112-bit segments. Packaging for discrete components can still be accommodated in a 3.5×6.25 inch panel-mounted enclosure, although the requirement to dissipate heat could become a serious problem. This analysis does not consider the heat problem and therefore limits the panel size to that indicated. The transponder, as in Comm C configuration, acts as the storage and forward medium for Comm C and D messages, generating the overhead and parity functions. All additional processing of data is accomplished in external avionics.

3.1.10 Large Scale Integration (LSI)

Present trends in avionics designs indicate that many manufacturers are taking advantage of the benefits in packaging and cost associated with the use of custom large scale integration. Where there is a large enough market for a particular type of avionics, the manufacturers are developing LSI chips to reduce assembly labor costs and packaging size, and to improve the reliability of the avionics. All the DABS configurations considered in this study have been designed with discrete logic to permit function sectionalization for adaptation to LSI technology. From a review of each configuration, the number of LSIs was estimated on the basis of densities, pinouts, and power disipation requirements, and an equivalent LSI version of the DABS transponder was developed.

The engineering department of King Radio provided a simple procedure for estimating the number of LSI devices necessary to perform the functions of discrete small scale integration (SSI) and medium scale integration (MSI) associated with any design. This procedure, applied to the detailed design

drawings developed for each configuration, consists of the following considerations:

- · An inverter can be implemented with one transistor on an LSI chip.
- Two input gates can be implemented with three transistors: two for each input and one for the output.
- A typical transistor can be implemented with 10 square mils of area. This is an estimate of a reasonably "tight" chip, but the estimate includes allowances for proper heat dissipation, routing paths, and buffer circuits.
- An LSI chip 200 mils on a side will provide approximately a 30 percent yield; this was considered acceptable for the purpose of this analysis. The chip size used provides an available area of 40,000 square mils.

In estimating the requirements of the function detailed on the design drawings, consideration was given to the practicability of including components that would unnecessarily burden an LSI in pinout or power dissipation. Integrated circuits (ICs) such as read-only memories (ROMs) and drivers for light emitting diodes (LEDs) were not included in the LSI but treated as separate devices in the configurations. Additional design changes were made to minimize pinout requirements. These included serialization of data for single pin input with later conversion to parallel form within the LSI chip. Finally, each integrated circuit was sized according to the number of one- and two-input gates necessary to perform its function, and this information was translated into the total number of transistors needed. With each transistor requiring 10 square mils the number of LSIs required for any of the DABS configurations could be estimated.

3.2 DEVELOPMENT OF TRANSPONDER COSTS

The cost of each transponder configuration identified in Section 3.1 was developed using traditional accounting methods. These methods require detailed parts identification for the production of modules, subassemblies, and systems. Each component was priced on the basis of OEM price lists for quantities necessary for production assemblies, with typical annual system production in the range of from one to three thousand units. A material handling charge of ten percent was added to the cost of materials to allow for inventory control, pre-testing, expected yield, and in-plant distribution. Calculations for assembly labor for each component were based on the nature of the component (i.e., two-lead devices, three-lead devices, etc.) using semiautomated insertion process. Labor rate is derived from Department of Labor statistics for the electronic industry, geographically corrected, and limited to the class of manufacturing for the general aviation community. A 1980 labor rate of \$5.60 per hour was assumed typical for the expected manufacturers of low-performance general aviation aircraft avionics. Since the labor rate used is direct hourly wage, a 135 percent overhead burden was applied to the labor costs to cover typical overhead expenses. The sum of the material and labor costs provides the direct

production cost of a module or the system. A 20 percent general and administrative (GA) charge and an expected 15 percent profit are included in determining the factory selling price of the unit. Since typical production practice is to manufacturer transponders in subassemblies, the complete system must be assembled and tested prior to release for sale. To account for this activity and expense, an "Assembly and Test" cost column is included in each cost analysis. The same markups and rates are used in this cost development, except that there are no material costs associated with the activity.

The standard distributor markup of 100 percent has been applied to identify the advertized "list price" of the system. This markup covers distribution costs, inventory management of the distributors, and warranties beyond those provided by the original manufacturers.

The following sections present the results of applying this cost estimating method to each configuration of DABS presented in Section 3.1. Detailed parts lists associated with each configuration are included in Appendix A. The LSI equivalent transponder is presented in each configuration following the discrete version to facilitate cost comparison. Each configuration, discrete and LSI, required one stub antenna (two for diversity) at a list price of \$19 added to the equipment cost to arrive at the system cost. This addition is considered in the life-cycle analyses presented in subsequent chapters.

3.2.1 Baseline DABS

The baseline transponder cost development is presented in Table 3-1 for the discrete version and in Table 3-2 for the LSI version. Both versions use the same IF amplifier module, modulator-demodulator module, and power supply modules. Decoding and encoding functions for the discrete version have been developed as a unit and then divided evenly for packaging on two printed circuit cards. The method for determining the number and size of cards was to allow one square inch of board space for each two ICs required. Since this version contains 150 ICs, and the useable panel width limits the PC card to six inches, with a practical depth limit the 75 square inches of area required to mount the ICs will be provided by two cards of 6 x 8 inches each. The extra space can be used to simplify printed circuit configuration. The equivalent LSI configuration requires four LSIs and 27 discrete integrated circuits. With the assumption that each 40-pin LSI requires two square inches of board space, the entire decode and encode function can be mounted on a single PC board not larger than 6 X 4 inches.

The costs for the enclosure and chassis, as well as those for the assembly and test, are almost the same for the two versions since there is very little difference between them. The minor material reduction for the sheet metal enclosure for the LSI version is not considered; the cost variation is the result of fewer connectors and less cabling for the LSI unit.

	Table	3-1.	COST OF BASELINE DABS		(DISCRETE VERSION)	(SION)		
				Module Cost	: in Dollars			
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	19.89	79.49	79.49	90.80	* *	328.27
Material Handling (10 percent of material cost)	4.43	1.44	1.99	7.95	7.95	80.6	I	32.83
Labor (\$5.60 per hour)	13.81	7.35	9.18	16.48	16.48	17.68	14.28	95.27
Burden (135 percent of labor cost)	18.64	9.92	12.39	22.24	22.24	23.87	19.28	128.58
Subtotal	81.13	33.06	43.45	126.16	126.16	141.43	33.56	584.95
G&A (20 percent of subtotal)	16.23	6.61	8.69	25.23	25.23	28.29	6.71	116.99
Total Direct Cost	97.36	39.67	52.14	151.39	151.39	169.72	40.27	701.94
Profit (15 percent of direct cost)	14.60	5.95	7.82	22.71	22.71	25.46	6.04	105.29
Factory Sell Price	111.96	45.62	59.96	174.10	174.10	195.18	46.31	807.23
Distribution (100 percent of factory price)	1	1	<u> </u>	1	!	1	1	807.23
List Price	;	-	ł	:	-	-		1,614.46

	Table 3-2.	1	ASELINE C	COST OF BASELINE DABS (LSI VERSION)	STON)		
			Modul	Module Cost in Dollars	llars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	19.89	73.52	89.54	;	241.55
Material Handling (10 percent of material cost)	4.43	1.44	1.99	7.35	8.95	1	24.16
Labor (\$5.60 per hour)	13.81	7.35	9.18	15.96	17.60	14.14	78.04
Burden (135 percent of labor cost)	18.64	9.92	12.39	21.55	23.76	19.09	105.35
Subtotal	81.13	33.06	43.45	118.38	139.85	33.23	449.10
G&A (20 percent of subtotal)	16.23	6.61	8.69	23.68	27.97	6.65	89.83
Total Direct Cost	97.36	39.67	52.14	142.06	167.82	39.88	538.92
Profit (15 percent of direct cost)	14.60	5.95	7.82	21.31	25.17	5.98	80.84
Factory Sell Price	111.96	45.62	59.96	163.37	192.99	45.86	619.76
Distribution (100 percent of factory price)	1	1	1	1	1	1	619.76
List Price	-	-	{		:		1,239.52

The pronounced cost difference in list price of \$375 (\$1614 for discrete and \$1239 for LSI) is accounted for in the reduced material cost and assembly labor associated with the logic processing using LSI technology. These costs, however, do not include the development cost of the four LSIs which may have to be amortized over a specific production quantity.

3.2.2 Baseline DABS with Antenna Diversity

Antenna diversity affects the receiver, modulator, and transmitter functions of the transponder. The diversity switch, included in the expanded demodulator-modulator subassembly, provides the decision for antenna selection and control of output transmitters. Tables 3-3 and 3-4 present the cost development of this configuration in the discrete and LSI versions. Since large scale integration has not been applied to the antenna diversity configuration with the exception of the processor card, all changes to the baseline configuration affected both versions identically. Two IF amplifiers will be required, preceded by low-pass filters and preselectors. A single DPSK demodulator shares the PC board that houses the diversity switch with logic control and dual modulators. The additional cavity oscillator required for diversity operation is included in the enclosure and chassis module. The list prices of \$2054 and \$1679 for discrete and LSI versions respectively maintain the \$375 difference shown for the baseline case.

3.2.3 Baseline DABS with 21.5 dBW at Antenna

Increasing power output to 21.5 dBW over the minimum 18.5 dBW specified in the DABS Draft National Standard is within the basic capability of the cavity oscillators used. The increase is the result of the additional storage capacity required in the power supplies of the transponder to provide a maximum 23.5 dBW power output. Tables 3-5 and 3-6 present the cost development for this configuration for the discrete and LSI versions.

3.2.4 DABS with Comm A and Comm B

The introduction of the 112-bit data field associated with Comm A and Comm B operation has a minor cost impact on the processing logic of DABS transponders. The total discrete chip count increases only from 150 to 156 ICs, not enough to change packaging considerations from those used for the baseline system. The LSI version would require four LSIs plus 30 discrete ICs. The three additional ICs are in the SSI and MSI category, but do not require more mounting surface than conventional ICs. The LSIs are customized for the Comm A and B application, and cannot be considered as the same as those developed for the baseline case. Table 3-7 presents the cost development for the discrete version, while Table 3-8 presents the cost development for the LSI version. Since additional communication capability does not affect analog signal processing, the remaining subassemblies are virtually the same as in the baseline case. Additional storage capacity for extended data transmission is included in the power supplies.

(Text continues on page 3-22.)

	Table 3-3.	L	COST OF BASELINE DABS WITH ANTENNA DIVERSITY (DISCRETE VERSION)	ITH ANTEN	NA DIVERSI	PY (DISCRETH	VERSION)		
				Module	Module Cost in Dollars	llars			
Cost Element	IF Amplifier	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	44.25	27.46	19.89	79.49	79.49	133.79	1	428.62
Material Handling (10 percent of material cost)	4.43	4.43	2.75	1.99	7.95	7.95	13.38	1	42.86
Labor (\$5.60 per hour)	13.81	13.81	10.46	9.18	16.48	16.48	19.53	16.38	116.13
Burden (135 percent of labor cost)	18.64	18.64	14.12	12.39	22.24	22.24	26.37	22.11	156.77
Subtotal	81.13	81.13	54.79	43.45	126.16	126.16	193.07	38.49	744.38
G&A (20 percent of Subtotal)	16.23	16.23	10.96	8.69	25.23	25.23	38.61	7.70	148.87
Total Direct Cost	97.36	97.36	65.75	52.14	151.39	151.39	231.68	46.19	893.25
Profit (15 percent of direct cost)	14.60	14.60	9.86	7.82	17.22	22.71	34.75	6.93	133.99
Factory Sell Price	111.96	111.96	75.61	59.96	174.10	174.10	266.43	53.12	1,027.24
Distribution (100 percent of factory price)	1	!	ţ	1	1	i	ŀ	;	1,027.24
List Price	-			1		-	;	ł	2,054.48

	Table 3-4.	COST OF BAS	COST OF BASELINE DABS WITH ANTENNA DIVERSITY	TH ANTENN	A DIVERSITY	(LSI VERSION)	2	
			MoM	lule Cost	Module Cost in Dollars			
Cost Element	IF Amplifier	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	44.25	27.46	19.89	73.52	132.53		341.90
Material Handling (10 percent of material cost)	4.43	4.43	2.75	1.99	7.35	13.25	ı	34.19
Labor (\$5.60 per hour)	13.81	13.81	10.46	9.18	15.96	19.44	16.24	98.90
Burden (135 percent of labor cost)	18.64	18.64	14.12	12.39	21.55	26.25	21.92	133.52
Subtotal	81.13	81.13	54.79	43.45	118.38	191.47	38.16	608.51
G&A (20 percent of subtotal)	16.23	16.23	10.96	8.69	23.68	38.29	7.63	121.70
Total Direct Cost	97.36	97.36	65.75	52.14	142.06	229.76	45.79	730.21
Profit (15 percent of direct cost)	14.60	14.60	9.86	7.82	21.31	34.46	6.87	109.53
Factory Sell Price	111.96	111.96	75.61	96.65	163.37	264.22	52.66	839.74
Distribution (100 percent of factory price)	1	1	1	{		1	1	839.74
List Price		:		-	-	1	:	1,679.48

Table 3-5. COST	OF BASELINE	COST OF BASELINE DABS WITH 21.5 dBW AT ANTENNA (DISCRETE VERSION)	11.5 dBW	AT ANTENN	IA (DISCRE	TE VERSION)		
			Mo	Module Cost	in Dollars	s		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	20.73	79.49	79.49	90.80	+	329.11
Material Handling (10 percent of material cost)	4.43	1.44	2.07	7.95	7.95	90.6	;	32.91
Labor (\$5.60 per hour)	13.81	7.35	9.23	16.48	16.48	17.68	14.28	95.32
Burden (135 percent of labor cost)	18.64	9.92	12.46	22.24	22.24	23.87	19.28	128.65
Subtotal	81.13	33.06	44.49	126.16	126.16	141.43	33.56	585.99
G&A (20 percent of subtotal)	16.23	6.61	8.90	25.23	25.23	28.29	6.71	117.20
Total Direct Cost	97.36	39.67	53.39	151.39	151.39	169.72	40.27	703.19
Profit (15 percent of direct cost)	14.60	5.95	8.01	22.71	22.71	25.46	6.04	105.48
Factory Sell Price	111.96	45.62	61.40	174.10	174.10	195.18	46.31	808.67
Distribution (100 percent of factory price)	;	<u> </u>	1	;	;	ŀ	1	808.67
List Price		-		;	<i>i</i>	;	1	1,617.34

Table 3-6. COST	OF BASELINE	COST OF BASELINE DABS WITH 21.5 dBW AT ANTENNA (LSI VERSION)	.5 dBW AT	ANTENNA (LSI VERSION)		
			Module	Module Cost in Dollars	ollars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	20.73	73.52	89.54	-	242.39
Material Handling (10 percent of material cost)	4.43	1.44	2.07	7.35	8.95	;	24.24
Labor (\$5.60 per hour)	13.81	7.35	9.23	15.96	17.60	14.14	78.09
Burden (135 percent of labor cost)	18.64	9.92	12.46	21.55	23.76	19.09	105.42
Subtotal	81.13	33.06	44.49	118.38	139.85	33.23	450.14
G&A (20 percent of subtotal)	16.23	6.61	8.90	23.68	27.97	6.65	90.03
Total Direct Cost	97.36	39.67	53.39	142.06	167.82	39.88	540.17
Profit (15 percent of direct cost)	14.60	5.95	8.01	21.31	25.17	5.98	81.03
Factory Sell Price	111.96	45.62	61.40	163.37	192.99	45.86	621.20
Distribution (100 percent of factory price)	!	ļ		}	}	1	621.20
List Price		-	-	-	1	-	1,242.40

	Table 3-7. (COST OF BASELINE DABS WITH COMM A AND B (DISCRETE VERSION)	INE DABS V	VITH COMM P	AND B (DIS	SCRETE VERSIC	(NC	
			£	odule Cost	Module Cost in Dollars			
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	85.15	85.15	08.06	-	342.11
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.52	8.52	90.6	1	34.21
Labor (\$5.60 per hour)	13.81	7.35	9.31	16.91	16.91	17.68	14.28	96.25
Burden (135 percent of labor cost)	18.64	9.92	12.57	22.83	22.83	23.87	19.28	129.95
Subtotal	81.13	33.06	46.53	133.41	133.41	141.43	33.56	602.53
GGA (20 percent of subtotal)	16.23	6.61	9.31	26.68	26.68	28.29	6.71	120.50
Total Direct Cost	97.36	39.67	55.84	160.09	160.09	169.72	40.27	723.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.01	24.01	25.46	6.04	108.46
Factory Sell Price	111.96	45.62	64.22	184.10	184.10	195.18	46.31	831.49
Distribution (100 percent of factory price)	1	1	<u> </u>	1	;	}	t t	831.49
List Price			;	!	;			1,662.98

Table	3-8.	COST OF BASELINE DABS WITH COMM A AND	DABS WITH	COMM A AND	B (LSI VERSION)	ON)	
			Modu]	Module Cost in Dollars	ollars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	87.65	89.54	-	258.20
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.77	8.95	1	25.82
Labor (\$5.60 per hour)	13.81	7.35	9.31	16.23	17.60	14.14	78.44
Burden (135 percent of labor cost)	18.64	9.92	12.57	21.91	23.76	19.09	105.90
Subtotal	81.13	33.06	46.53	134.56	139.85	33.23	468.36
G&A (20 percent of subtotal)	16.23	6.61	9.31	26.91	27.97	6.65	93.67
Total Direct Cost	97.36	39.67	55.84	161.47	167.82	39.88	562.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.22	25.17	5.98	84.31
Factory Sell Price	111.96	45.62	64.22	185.69	192.99	45.86	646.34
Distribution (100 percent of factory price)	ţ	1	!	!	!	1	646.34
List Price	1		-	-			1,292.68

3.2.5 DABS with Comm A and B and ATARS

The cost of introducing 'TARS can be identified in the cost of development of the two ATARS boards. As for the decode-encode cards, the ATARS components were identified from the detailed design, costs for materials and assembly labor were estimated, and the costs were divided equally to establish the cost of each card. These cards are expected to measure 6 x 3.25 inches each and will be mounted vertically directly behind the front panel. The ATARS function requires 73 discrete integrated circuits. Alpha-numeric displays and command advisory LEDs are included in the cost of the cards but will be mounted in the front panel. Table 3-9 presents the cost development of the discrete version of this configuration; Table 3-10 presents the comparable cost development of the LSI version. The ATARS functions are integrated into the main processing board, resulting in a PC board that has five LSIs and 55 discrete integrated circuits. The 25 additional ICs required for ATARS are used primarily as drivers of the LED displays and normal interface between the LSIs and displays.

3.2.6 DABS with Comm A and B, ATARS, and BCAS Interface

The expansion of the processing functions by addition of the BCAS interface required repackaging of the encoder-decoder logic boards. The 187 chips required to process all the logic, not including ATARS, exceed the capacity of two boards sized for a modern transponder. Therefore three boards have been proposed. The cost development summary is presented in Table 3-11. The LSI version, however, is not affected in material cost because the BCAS interface functions can be incorporated into the custom LSI design without exceeding the density criteria of each LSI. Table 3-12 presents the cost development of this configuration. It is identical to the cost of the DABS with ATARS, although the LSIs are different in design.

3.2.7 DABS with Comm A and B and Uplink ELM (Comm C)

The ELM function can best be processed using modern microcomputers with appropriate memory devices. Table 3-13 presents the cost development of this DABS configuration in the discrete version. The LSI version is shown in Table 3-14. The same microcomputer is used in this version since incorporating the ELM function in a custom LSI is not considered cost effective. All components in this configuration are MSIs or LSIs already.

3.2.8 DABS with Comm A and B, ATARS, and Comm C

The transponder with complete uplink data capability, including the traffic advisory information of ATARS, results in a unit that would have a list price of \$2261 for the discrete version of logic and a list price of \$1719 for the LSI version. The costs for the two versions are presented in Tables 3-15 and 3-16. The ATARS function is designed for separate printed circuit-board configuration in the discrete version; it is an additional cost when added to the configuration of Section 3.2.7. However the LSI version requires a single large PC board, which includes all the data link and ATARS logic. This requires five custom LSIs and 58 discrete

(Text continues on page 3-33.)

	Table 3-9.	1	F BASELIN	E DABS WIT	н сомм а ал	ND B AND A	TARS (DISC	COST OF BASELINE DABS WITH COMM A AND B AND ATARS (DISCRETE VERSION)		
					Module	Module Cost in Dollars	Dollars			
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	ATARS Board 1	ATARS Board 2	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	85.15	85.15	52.34	52.34	86.46	+	442.45
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.52	8.52	5.23	5.23	8.65	1	44.25
Labor (\$5.60 per hour)	13.81	7.35	9.31	16.91	16.91	10.27	10.27	12.48	18.34	115.65
Burden (135 percent of labor cost)	18.64	9.93	12.57	22.83	22.83	13.86	13.86	16.85	24.76	156.13
Subtotal	81.13	33.06	46.53	133.41	133.41	81.70	81.70	124.44	43.10	758.48
GéA (20 percent of subtotal)	16.23	6.61	9.31	26.68	26.68	16.34	16.34	24.89	8.62	151.70
Total Direct Cost	97.36	39.67	55.84	160.09	160.09	98.04	98.04	149.33	51.72	910.18
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.01	24.01	14.71	14.71	22.40	1.76	136.53
Factory Sell Price	111.96	45.62	64.22	184.10	184.10	112.75	112.75	171.73	59.48	1,046.71
Distribution (100 percent of factory price)	1	1	1	1	<u> </u>	ŀ	!	!	ŀ	1,046.71
List Price	1	1	1	ł		ŀ		1		2,093.42

Table 3-10.	1	COST OF BASELINE DABS WITH COMM A AND B AND ATARS (LSI VERSION)	S WITH CC	MM A AND B	AND ATARS (LSI VERSION	1)
			Modu	Module Cost in Dollars	Collars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	155.44	84.68		321.13
Material Handling (10 percent of material cost)	4.43	1.44	2.24	15.54	8.47	1	32.11
Labor (\$5.60 per hour)	13.81	7.35	9.31	29.88	16.81	17.92	95.08
Burden (135 percent of labor cost)	18.64	9.92	12.57	40.34	22.70	24.19	128.37
Subtotal	81.13	33.06	46.53	241.20	132.66	42.11	576.69
G&A (20 percent of subtotal)	16.23	6.61	9.31	48.24	26.53	8.42	115.34
Total Direct Cost	97.36	39.67	55.84	289.44	159.19	50.53	692.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	43.42	23.88	7.58	103.81
Factory Sell Price	111.96	45.62	64.22	332.86	183.07	58.11	795.84
Distribution (100 percent of factory price)	1	ł	l	ŀ	ł	1	795.84
List Price	1	{	1	i	-	-	1,591.68

	Table 3-11.	. COST OF BAL	ELINE DA	35 WITH CO	IM A AND B,	ATARS, AND	BCAS INTER	FACE (DISCF	COST OF BASELINE DABS WITH COMM A AND B, ATARS, AND BCAS INTERFACE (DISCRETE VERSION)		
					Module	Module Cost in Dollars	llars				
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Logic Board I	Logic Board II	Logic Board III	ATARS Board 1	ATARS Board 2	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	59.54	59.54	59.54	52.34	52.34	87.72	:	452.03
Material Handling (10 percent of material cost)	4.43	1.44	2.24	5.95	5.95	5.95	5.23	5.23	8.77	l	45.20
Labor (\$5.60 per hour)	13.81	7.35	9.31	13.47	13.47	13.47	10.27	10.27	12.57	18.48	122.46
Burden (135 percent of labor cost)	18.64	9.92	12.57	18.18	18.18	18.18	13.86	13.86	16.96	24.95	165.30
Subtotal	81.13	33.06	46.53	97.14	97.14	97.14	81.70	81.70	126.02	43.43	784.99
GLA (20 percent of subtotal)	16.23	6.61	9.31	19.43	19.43	19.43	16.34	16.34	25.20	8.69	157.01
Total Direct Cost	97.36	39.67	55.84	116.57	116.57	116.57	98.04	98.04	151.22	52.12	942.00
Profit (15 percent of direct cost)	14.60	5.95	8.38	17.49	17.49	17.49	14.71	14.71	22.68	7.82	141.32
Factory Sell Price	111.96	45.62	64.22	134.06	134.06	134.06	112.75	112.75	173.80	59.94	1,083.32
Distribution (100 percent of factory price)	1	;	1	1	1	1	:	!	1	1	1,083.32
List Price	:	;	1	1	1	1	1	!	!	ł	2,166.64

Table 3-12. COST	OF BASELINE	COST OF BASELINE DABS WITH COMM A AND B AND ATARS AND BCAS INTERPACE (LSI VERSION)	M A AND	AND ATARS	AND BCAS INT	ERPACE (LSI	VERSTON)
			[npo#	Module Cost in Dollars	ollars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	155.44	84.68	1	321.13
Material Handling (10 percent of material cost)	4.43	1.44	2.24	15.54	8.47	1	32.11
Labor (\$5.60 per hour)	13.81	7.35	9.31	29.88	16.81	17.92	95.08
Burden (135 percent of labor cost)	18.64	9.92	12.57	40.34	22.70	24.19	128.37
Subtotal	81.13	33.06	46.53	241.20	132.66	42.11	576.69
GAA (20 percent of subtotal)	16.23	6.61	9.31	48.24	26.53	8.42	115.34
Total Direct Cost	97.36	39.67	55.84	289.44	159.19	50.53	692.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	43.42	23.88	7.58	103.81
Factory Sell Price	111.96	45.62	64.22	332.86	183.07	58.11	795.84
Distribution (100 percent of factory price)	ł	1	1	l	1	!	795.84
List Price	1	1	ŧ		1	1	1,591.68

72	Table 3-13. C	COST OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK (DISCRETE VERSION)	NE DABS &	VITH COMM A !	IND B AND ELM	UPLINK (1	DISCRETE VERS	SION)	
				Module	Module Cost in Dollars	ars		:	
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	IF Logic Amplifier	DPSK Demod Logic Modulator	Power Logic Supply	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	64.26	64.26	64.26	92.06	-	365.85
Material Handling (10 percent of material cost)	4.43	1.44	2.24	6.43	6.43	6.43	9.21	!	36.59
Labor (\$5.60 per hour)	13.81	7.35	9.31	14.24	14.24	14.24	17.76	20.02	110.97
Burden (135 percent of labor cost)	18.64	9.92	12.57	19.22	19.22	19.22	23.98	27.02	149.82
Subtotal	81.13	33.06	46.53	104.15	104.15	104.15	143.01	47.04	663.23
G&A (20 percent of subtotal)	16.23	6.61	9.31	20.83	20.83	20.83	28.60	9.41	132.64
Total Direct Cost	97.36	39.67	55.84	124.98	124.98	124.98	171.61	56.45	795.87
Profit (15 percent of direct cost)	14.60	5.95	8.38	18.75	18.75	18.75	25.74	8.47	119.38
Factory Sell Price	111.96	45.62	64.22	143.72	143.72	143.72	197.35	64.92	915.25
Distribution (100 percent of factory price)	1	1	1	1	1	1	1	l	915.25
List Price	1	;	;			-	-	1	1,830.50

rable 3-14. COST OF	F BASELINE D	COST OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK (LSI VERSION)	A AND B	AND ELM UP	LINK (LSI VE	RSION)	
			Module	Module Cost in Dollars	ollars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	112.42	89.54	1	282.97
Material Handling (10 percent of material cost)	4.43	1.44	2.24	11.24	8.95	-	28.30
Labor (\$5.60 per hour)	13.81	7.35	9.31	17.62	17.60	19.74	85.43
Burden (135 percent of labor cost)	18.64	9.92	12.57	23.78	23.76	26.65	115.32
Subtotal	81.13	33.06	46.53	165.06	139.85	46.39	512.02
G&A (20 percent of subtoral)	16.23	6.61	9.31	33.01	27.97	9.28	102.41
Total Direct Cost	97.36	39.67	55.84	198.07	167.82	55.67	614.43
Profit (15 percent of direct cost)	14.60	5.95	8.38	29.71	25.17	8,35	92.16
Factory Sell Price	111.96	45.62	64.22	227.78	192.99	64.02	706.59
Distribution (100 percent of factory price)	1	1	}	1	!	1	706.59
List Price	;	;	-	ì	-	;	1,413.18

Table 3-15.	-15. COST OF	OF BASELINE	ABS WITH	COMM A AN	BASELINE DABS WITH COMM A AND B, ATARS, AND ELM UPLINK (DISCRETE VERSION)	AND ELM UP	LINK (DISC	RETE VER	SION)		
					Module C	Module Cost in Dollars	ars				
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Processor	Processor	Processor	ATARS Board 1	ATARS Board 2	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.23	22.41	64.26	64.26	64.26	52.34	52.34	87.72		466.19
Material Handling (10 percent of material cost)	4.43	1.44	2.24	6.43	6.43	6.43	5.23	5.23	8.77	1	46.62
Labor (\$5.60 per hour)	13.81	7.35	9.31	14.24	14.24	14.24	10.27	10.27	12.57	24.08	130.38
Burden (135 percent of labor cost)	18.64	9.92	12.57	19.22	19.22	19.22	13.86	13.86	16.96	32.51	176.00
Subtotal	61.13	33.06	46.53	104.15	104.15	104.15	91.70	81.70	126.02	56.59	819.19
GEA (20 percent of subtotal)	16.23	6.61	9.31	20.83	20.83	20.83	16.34	16.34	25.20	11.32	163.84
Total Direct Cost	97.36	39.67	55.84	124.98	124.98	124.98	98.04	98.04	151.22	67.91	983.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	18.75	18.75	18.75	14.71	14.71	22.68	10.19	147.46
Factory Sell Price	111.96	45.62	64.22	143.72	143.72	143.72	112.75	112.75	173.90	78.10	1,130.46
Distribution (100 percent of factory price)	;	:	;	!	:		1	1		1	1,130.46
List Price	}	-	!	;	-	-	1			1	2,260.92

Table 3-16. COS	ST OF BASELI	COST OF BASELINE DABS WITH COMM A AND B, ATARS, AND ELM UPLINK (LSI VERSION)	COMM A ANE	B, ATARS, P	ND ELM UPLI	NK (LSI VER	SION)
			Modul	Module Cost in Dollars	llars		
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	179.21	84.68	1	344.90
Material Handling (10 percent of material cost)	4.43	1.44	2.24	17.92	8.47	ı	34.49
Labor (\$5.60 per hour)	13.81	7.35	9.31	32.78	16.81	23.52	103.58
Burden (135 percent of labor cost)	18.64	9.92	12.57	44.26	22.70	31.75	139.85
Subtotal	81.13	33.06	46.53	274.17	132.66	55.27	622.82
GLA (20 percent of subtotal)	16.23	6.61	9.31	54.83	26.53	11.05	124.57
Total Direct Cost	97.36	39.67	55.84	329.00	159.19	66.32	747.39
Profit (15 percent of direct cost)	14.60	5.95	8.38	49.35	23.88	9.95	112.10
Factory Sell Price	111.96	45.62	64.22	378.35	183.07	76.27	859.49
Distribution (100 percent of factory price)	!	1	ļ	1	1	ì	859.49
List Price	-	-	1 **	:		-	1,718.98

		Table 3-17. CC	OST OF DABS	S WITH COMM A	COST OF DABS WITH COMM A AND B AND COMM C AND D (DISCRETE VERSION)	UM C AND D (D)	ISCRETE VERSION	(NC		
					Module Cost in Dollars	in Dollars				
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Processor	Processor	Processor	Power Amplifier	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	23.30	91.39	71.39	71.39	117.47	62.06	+	475.60
Material Handling (10 percent of material cost)	4.43	1.44	2.33	7.14	7.14	7.14	11.75	6.21	!	47.56
Labor (\$5.60 per hour)	13.81	7.35	9.54	14.76	14.76	14.76	9.14	16.50	20.16	120.78
Burden (135 percent of labor cost)	18.64	9.92	12.88	19.93	19.93	19.93	12.35	22.28	27.22	163.10
Subtotal	81.13	33.06	48.05	113.22	113.22	113.22	150.71	107.05	47.38	807.04
GLA (20 percent of subtotal)	16.23	6.61	9.61	22.64	22.64	22.64	30.14	21.41	9.48	161.40
Total Direct Cost	97.36	39.67	57.66	135.86	135.86	135.86	180.85	128.46	56.86	968.44
Profit (15 percent of direct cost)	14.60	5.95	8.65	20.38	20.38	20.38	27.13	19.27	8.53	145.27
Factory Sell Price	111.96	45.62	66.31	156.24	156.24	156.24	207.98	147.73	65.39	1,113.71
Distribution (100 percent of factory price)	!	ł	1	!	;	ì	i	:	ţ	1,113.71
List Price	:	-	:	-		- *	!	1	ţ	2,227.42

Table 3-18.	COST	OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK AND DOWNLINK (LSI VERSION)	ITH COMM A	A AND B AND	ELM UPLINK AN	D DOWNLINK (L	SI VERSION)	
				Module Cost	in Dollars			
Cost Element	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Power Amplifier	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	23.30	124.39	117.47	59.54	••	383.30
Material Handling (10 percent of material cost)	4.43	1.44	2.23	12.44	11.75	5.95	:	38.33
Labor (\$5.60 per hour)	13.81	7.35	9.54	18.36	9.14	16, 33	20.72	95.25
Burden (135 percent of labor cost)	18.64	9.92	12.88	24.78	12.35	22.05	27.97	128.59
Subtotal	81.13	33.06	48.05	179.97	150.71	103.87	48.69	645.47
GGA (20 percent of subtotal)	16.23	6.61	9.61	35.99	30.14	20.77	9.74	129.09
Total Direct Cost	97.36	39.67	57.66	215.96	180.85	124.64	58.43	774.57
Profit (15 percent of direct cost)	14.60	5.95	8.65	32.39	27.13	18.70	8.76	116.18
Factory Sell Price	111.96	45.62	66.31	248.35	207.98	143.34	67.19	890.75
Distribution (100 percent of factory price)	!	1	\	!	1	1	1	890.75
List Price	;	-	-	-			1	1,781.50

Table	3-19. COST	OF ATCRBS (DISCRETE	/ERSION)	
		Module (Cost in Do	llars	
Cost Element	Receiver	Main PC Board	Chassis	Assembly and Test	Total
Material Cost	26.79	49.37	69.72		145.88
Material Handling (10 percent of material cost)	2.68	4.94	6.97		14.59
Labor (\$5.60 per hour)	11.45	11.83	8.51	10.64	42.43
Burden (135 percent of labor cost)	15.45	15.97	11.49	14.36	57.27
Subtotal	56.37	82.11	96.69	25.00	260.17
G&A (20 percent of subtotal)	11.27	16.42	19.34	5.00	52.03
Total Direct Cost	67.64	98.53	116.03	30.00	312.20
Profit (15 percent of direct cost)	10.15	14.78	17.40	4.50	46.83
Factory Sell Price	77.79	113.31	133.43	34.50	359.03
Distribution (100 percent of factory price)					359.03
List Price					718.06

ICs and integrates all functions. The front panel display requires 3.5 inches of height for either version, controlling one dimension of packaging requirements.

3.2.9 DABS with Comm A and B and Comm C and D

The high duty cycle associated with downlink ELM (Comm D) transmissions dictated the design and cost development of solid-state power amplifiers.

Table 3-17 presents the cost development of the discrete version of this DABS configuration; Table 3-18 presents the LSI version. Data processing in the discrete version is accomplished on three printed circuit boards using discrete ICs for most of the required functions and a microcomputer with one peripheral for the ELM functions. A total of 176 chips are required, including 1 in the microcomputer family, to provide the DABS capability for Comm A, B, C, and D. The equivalent LSI version can accomplish the functions with four LSIs, one microcomputer with one family chip, and 30 discrete ICs. The solid-state power amplifier and power supply modules are common to both versions and provide 18.5 dBW output power at the antenna terminals. The power is developed by using four chains of cascading microwave transistors with a final output of 150 watts at 50 volts. The cost of the transistors alone is \$90. The list price of the amplifier is \$416. This is considerably higher than the equivalent oscillator tube amplifier, which has a user replacement price of \$178. However, the solid-state amplifier would be capable of transmitting 16 segments of Comm D data consecutively without exceeding the rated duty factor of the transistors. The power supply includes two large storage capacitors that provide the required 25,000 microfarads of energy without exceeding a 2-dB degradation in output power. Additional storage capacitors are included in the 28-volt and 50-volt stages of the power amplifier.

3.2.10 ATCRBS Transponder

The costs for the various DABS configurations were developed using a typical piece count pricing method. Since the cost factors used are typical of electronic manufacturers, their applicability to the avionics community can be challenged. The FAA requested us to use the same method on a typical modern ATCRBS transponder whose list price is nationally advertised to permit comparison of the results with advertised list prices. A modern transponder was chosen and evaluated by the piece part method. The detailed list of component parts used and assembly labor estimates are presented in Appendix A. Table 3-19 presents the cost development based on the ATCRBS material and labor estimates and the same cost factors used in DABS cost development. The resulting list price of \$718 is quite close to the advertised price of \$695. The difference can be attributed to a lower profit on transponders because of the intense competition in the sales of these popular avionics.

3.3 TRANSPONDER RELIABILITY

The reliability of each of the systems was reviewed and evaluated. The detailed parts lists developed for cost evaluation permitted application of the MIL-217C* reliability-prediction technique in the determination of system or module mean time between failure (MTBF) by component failure rate.

^{*}Military Standardization Handbook, Reliability Stress and Failure Rate Data for Electronic Equipment, MIL-HDBK-217C, 9 April 1979.

When the MIL-217C reliability-prediction technique is used, it is necessary to make assumptions regarding key system operating parameters. For example, the operating ambient temperature was chosen at 40° C. The stress ratio (ratio of operating value to maximum rated value) for components was assumed to be 0.5. Junction temperatures used were those listed in D.A.T.A. Reference Standards for Industry, as applicable to the semiconductor class. Critical transistors, e.g., modulators, were evaluated to establish the normalized junction temperature (T_n) , and failure rates were derived from curves and data tables of MIL-217C. The environmental factor for airborne application was used for all calculations.

The reliability evaluations of the systems considered all electronic components in the circuits of the systems. A failure of any component was treated as causing a failure of the system.

The average material cost per repair action was developed by determining the contribution of any component to the module's reliability on the basis of that component's cost and expected failure rate.

The detailed development of these data is presented in Appendix A. The data are presented as failure rates per million hours of operation. The MTBF for any module can be calculated by application of the following formula:

$$MTBF = \frac{1 \times 10^6}{\text{Failure Rate}}$$
 (3-1)

System reliability can be determined by addition of all module failure rates and application of Equation 3-1. Transponder MTBFs are shown in Table 3-20.

3.4 SUMMARY OF TRANSPONDER COSTS

The costs developed in this chapter considered various configurations of DABS transponders with both discrete and LSI logic designs. Table 3-20 presents a summary of the costs developed for each configuration. Since each configuration is unique, requiring designs that optimize the data processing for that configuration, the difference between any sets of custs should not be considered as the expected cost of later adding the particular capability. For example the cost of adding ATARS capability to an existing DABS transponder with Comm A/B capability should not be expected to be only \$430, the difference between the costs of installing DABS with and without ATARS. Rather the cost of the DABS with ATARS can be expected to be \$2,093 if designed originally into the system, and the cost of DABS without ATARS would be only \$1,663. Even though the acquisition cost of the LSI versions average 23 percent less than the discrete versions, the cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. The effect of amortization is considered in the life-cycle-cost analysis of subsequent chapters.

Table 3-20. TRANSPONDER RELIABILITY (MTBF	IN HOURS)	
Managar Configuration	Compone	ents
Transponder Configuration	Discrete	LSI
ATCRBS	2,170	
Basic Surveillance DABS	1,580	1,755
Basic DABS with Antenna Diversity	1,080	1,160
Basic DABS with 21.5 dBW at Antenna	1,580	1,755
DABS with Comm A and B	1,570	1,745
DABS with Comm A and B and ATARS	1,600	1,865
DABS with Comm A and B, ATARS, and BCAS Interface	1,575	1,865
DABS with Comm A, B, and C	1,740	1,990
DABS with Comm A, B, and C and ATARS	1,570	1,830
DABS with Comm A, B, C, and D	1,420	1,600

A study of Table 3-21 allows an evaluation of the comparative costs associated with designing a desired level of DABS capability.

Table 3-21. ACQUISITION COST OF TRANSF (CONSTANT 1980 DOLLARS)	PONDERS	
Muse an and an Confi muse ties	Compone	ents
Transponder Configuration	Discrete	LSI
ATCRBS	718	
Basic Surveillance DABS	1,614	1,239
Basic DABS with Antenna Diversity	2,054	1,679
Basic DABS with 21.5 dBW at Antenna	1,617	1,242
DABS with Comm A and B	1,663	1,293
DABS with Comm A and B and ATARS	2,093	1,592
DABS with Comm A and B, ATARS, and BCAS Interface	2,167	1,592
DABS with Comm A, B, and C	1,830	1,413
DABS with Comm A, B, and C and ATARS	2,261	1,719
DABS with Comm A, B, C, and D	2,227	1,781

CHAPTER FOUR

LIFE-CYCLE-COST MODEL COMMON PARAMETERS

This chapter addresses the development of those data items that are treated in the economic analysis as being common to any DABS concept. They include the estimated installation costs of transponders and the population projections for the low-performance general aviation community.

4.1 COST OF DABS ELECTRONICS COMPONENTS

The equipments studied have been limited to the airborne elements of the DABS system. Chapter Three developed the cost of the various DABS configurations that may be implemented in the low-performance general aviation aircraft community. In all cases it was assumed that the DABS electronics would be integrated into a single package and that the installation would consist of the transponder, cables, and antenna. Since the DABS operates on the same frequencies as the present ATCRBS it was assumed that the aircraft would use the low-cost quarter-wavelength stub antenna.

4.2 AIRCRAFT CONFIGURATION

The complement of equipment to be installed by a user normally depends on individual needs, probable flight profiles, the reliabilities required to provide suitable aircraft availability, and the anticipated or required flight crews for special classes of aircraft. Since this study is limited to low-performance general aviation aircraft it is assumed that the aircraft owner will carry the minimum avionics consistent with flight regulations and safety. This assumed installation will consist of a single set of DABS electronics with the electronics being installed in the flight console of the aircraft. It has been assumed that retrofit systems will reuse existing ATCRBS antenna installations.

4.3 INSTALLATION COSTS

The cost of equipment installation considered in this study falls into two categories: (1) retrofit of the existing fleet, and (2) installation in new aircraft.

Low-performance general aviation aircraft retrofit cost data were developed by a survey of avionics maintenance facilities because the majority of low-performance general aviation aircraft are maintained at such facilities

throughout the country. In 1974 more than 500 maintenance facilities were surveyed to solicit information on the labor requirement to retrofit a NARCO DME-190 unit with an appropriate antenna in the low-performance class of aircraft. The results of this survey were published in Report No. FAA-EM-76-1. In 1979 ARINC Research interviewed a selected sample of the responding maintenance organizations and obtained their new labor rates for comparison with those furnished in 1974. The labor estimations obtained in 1974 were in hours and were still considered valid. These new labor and material costs were published in Report No. FAA-EM-79-14. We updated the labor and material cost from FAA-EM-79-14 by using a Bureau of Labor Statistics inflation factor of 9.23 percent to arrive at a new base labor rate of \$25.25 per hour. Table 4-1 presents the expected labor and material cost of retrofitting avionics in the low-performance aircraft by using the 1980 labor rate and cost of materials.

		FIT INSTALLAT E GENERAL AVI		
	-	le-Engine rcraft	l	n-Engine .rcraft
Cost Category	Hours*	Cost (at \$25.25 per hour)	Hours*	Cost (at \$25.25 per hour)
Electronics	4.51	113.88	6.43	162.36
Antenna	2.32	58.58	3.21	81.05
Cabling	3.92	98.98	5.31	54.35
Material		40.43		54.35
Total Installation Cost		311.87		431.84

^{*}Installation times are based on the mean of labor hours quoted by 125 facilities.

For purposes of this analysis we used a weighted average of \$325 for a complete installation in the low-performance general aviation aircraft. We then assumed that the cost of antenna installation would be eliminated on the premise that the majority of general aviation aircraft are already equipped with ATCRBS transponders and the existing antenna would be reusable. This reduced the retrofit cost to \$264. For aircraft that require an antenna installation the increased cost is offset (in the population average) by elimination of the cost to remove existing equipment and the reduction of unit installation cost because of space availability. We did include the cost of a new antenna in the acquisition costs because manufacturers normally include an antenna as part of the installation kit.

It was assumed that installation costs in new general aviation aircraft would be 60 percent of the estimated retrofit costs of \$325 for a complete installation, or \$195. For antenna diversity, the retrofit installation

cost would be \$344 and the installation in a new aircraft would be \$242. These costs include the extra antenna required.

4.4 AIRCRAFT SCENARIO

Installation of DABS in aircraft is assumed to begin in 1987. It is assumed that all new aircraft delivered in 1987 and in subsequent years would have DABS installed as part of the original required avionic equipment. The retrofit period for the low-performance general aviation community has been assumed for purposes of this study to be 14 years, with the number of retrofits being a linear function. It is assumed that 85 percent of the projected active aircraft population will be retrofitted with DABS by 2001, with the retrofit period beginning in 1987. The remaining 15 percent are assumed to be inactivated or to fall into the category of aircraft normally not equipped with transponders.

To develop an aircraft baseline for 1987 and project an expected installation schedule for DABS, we reviewed a number of documents. Among these were FAA-AVP-80-8 of September 1980, FAA Aviation Forecasts FY 1981-1992; FAA-AVP-79-9 of September 1979, FAA Aviation Forecast FY 1980-1991; FAA-AVP-78-11 of September 1978, FAA Aviation Forecasts FY 1979-1990; FAA-MS-79-5 of April 1979, 1977 General Aviation Activity and Avionics Survey; FAA-MS-80-5 of March 1980, 1978 General Aviation and Avionics Survey; FAA Statistic Handbook of Aviation for 1978; and the World Aviation Directory, Volumes No. 75 through No. 80. Our purpose was to balance projections with production quantities to determine an increment of new aircraft per year. Most forecasts deal only with actual total fleet increases per year without separate categories for new aircraft per year and aircraft lost to attrition each year. Table 4-2 presents the baseline category for 1 January 1979. We chose this date because of the data agreement between FAA-MS-80-5 and FAA-AVP-80-8 on that date. Table 4-2 shows not only the baseline year but the projected change in active aircraft population by year. The extensive data base available in FAA-MS-79-5 and FAA-MS-80-5 allowed the determination that approximately 17 percent of the multi-engine piston aircraft were in the high-performance category. Combining this percentage with the assumed 10 percent of multi-engine aircraft in the high-performance category taken from FAA-EM-76-1, Cost Analysis of Airborne Collision Avoidance Systems (CAS) concepts, we projected that approximately 28 percent of the multi-engine piston aircraft would be in the high-performance category in 1987.

The data from Table 4-2 were combined with data from FAA-AVP-80-8 to project the expected active aircraft population in Table 4-3. Table 4-3 combines all low-performance aircraft types into one category and weighs the statistics of Table 4-2 to project a statistical data base for 1 January 1987.

The average flight hours per year per aircraft is a weighted average of all aircraft in a category. Table 4-3 forms the basis of aircraft-particular parameters such as quantities, flight hours, and production schedules for the airborne portion of the LCC study. It is based on current aircraft production rates, aircraft exports, and FAA projections.

Table 4-2. BASELINE AIRCRAFT DATA FOR LOW-PERFORMANCE
GENERAL AVIATION AIRCRAFT (AS OF JANUARY
1979)

Aircraft Categories
Single-Engine
Engine
Rotorcraft
Active Aircraft
160,651
19,232
5,315

172

10,900

266

1,500

422

450

Average Flight Hours

Projected New Aircraft

per Year

per Year

Table 4-3. LIFE-CYCLE-COST DATA FOR LOW-PEF GENERAL AVIATION	RFORMANCE
Aircraft Category	Quantity
Statistical Data as of 1 Jan	nuary 1979
Active Aircraft	185,200
New Aircraft Added per Year	12,850
Approximate Fleet Increase per Year	7,520
Statistical Data as of 1 Jan	nuary 1987
Projected Active Aircraft	245,360
Average Flight Hours per Year per Aircraft	189
Projected Average Number of Transponders Installed in New Aircraft per Year	12,850
Projected Average Tran- sponders Retrofitted per Year	14,900

4.5 MAINTENANCE SCENARIO

The maintenance scenario used in the life-cycle-cost model considers two levels of repair: on-aircraft and off-aircraft maintenance. On-aircraft

maintenance consists of simple removal and replacement of failed units. Off-aircraft maintenance encompasses all other maintenance actions required in the event of an equipment failure.

4.5.1 On-Aircraft Maintenance

On-aircraft maintenance is limited to the cost of removing and replacing failed units. Preventive maintenance was not considered because the general aviation user community does not generally provide preventive maintenance for transponders.

Remove and replace actions are initiated when an aircraft lands at a repair facility and reports a transponder failure. The cost incurred is for the time required to complete the maintenance action charged on an hourly basis. For the purposes of this analysis, the time required was assumed to be 1.5 hours, broken down as follows:

- · 15 minutes for the maintenance person to get to the aircraft
- · 15 minutes to remove the failed unit
- 15 minutes to take the failed unit back to the shop for testing and repair or replacement
- 15 minutes to return to the aircraft with the repaired or replacement unit
- · 15 minutes to reinstall the unit in aircraft
- 15 minutes to return to the shop

While the time allotted may appear excessive, it allows for the consideration that some repair shops are not located at airport facilities.

4.5.2 Off-Aircraft Maintenance

Off-aircraft maintenance costs are those costs incurred during the actual repair of a failed module. These expenses include the cost of materials, labor, shipping, and failure documentation.

Module repair at the avionics repair shop is restricted to bench testing and removal and replacement of the failed modules within the transponder. Repair times are attributed to the transponder and to each module. Since minimal spares, e.g., one of each type, are inventoried at avionics repair shops, users may often have to wait to have their repaired units returned to them. This waiting period is reflected in the avionics repair shop and depot pipeline (turnaround) times and order/ship times for replacement modules.

No modules, with the exception of the chassis, are assumed to be repaired at the avionics shops. Rather, the failed modules are shipped to a depot, or manufacturer, for repair. Eight depots were presumed throughout this analysis because in the past there have been eight manufacturers of ATCRBS transponders.

Once the failed unit arrives at the depot it is repaired, or in some cases replaced, incurring both a materials cost and a labor cost. These costs are peculiar to the particular module being repaired. The maintenance action is then documented and the repaired item shipped back to the avionics repair shop, thus completing the off-aircraft maintenance cycle. Module repair was assumed to vary between 0.60 and 1.35 hours, depending on the module.

It was assumed that in the initial year of DABS implementation there would be 50 avionics repair shops. This was based on the relatively small number (207) of pulse equipment repair shops existing today as listed in the FAA Advisory Circular AC/140-7A of 18 April 1980, Federal Aviation Administration Certificated Maintenance Agencies Directory. We assumed that the repair shops total would increase by 15 shops per year because of the continuing increase in transponders.

CHAPTER FIVE

INDIVIDUAL AND FLEET COSTS FOR DABS IMPLEMENTATION

5.1 COST MODEL

ARINC Research Corporation adapted and updated its Economic Analysis Model (EAM) for this study to evaluate the economic impact of the DABS transponder on the low-performance general aviation aircraft community. In particular the model calculates the cost of each DABS configuration and provides a basis for comparing costs between the levels of complexity that may be designed into the general aviation transponder.

The model has been programmed in FORTRAN IV+ for use with a Digital Equipment Corporation PDP-11/34 minicomputer. It computes the expected annual and cumulative acquisition, installation, and logistic support costs for each concept. The program is flexible so that data changes can be readily implemented, sensitivity evaluations performed, or additional data outputs obtained. The program features and mathematical formulation of the EAM are documented in Appendix B to this report. Appendix C is a program listing of the EAM.

5.2 ADDITIONAL INPUTS REQUIRED BY THE MODEL

The data developed in Chapter Three consitute only a portion of the data required to compare systems or establish the cost of implementation. Many parameters contributing to the evaluation of the systems and lifecycle costs are dictated by the GA user community. These data were developed, as were other parameters required by the model, through research completed for this and other contracts by ARINC Research Corporation.

A complete list of the parameters influencing the LCC evaluation is tabulated in Appendix D to this report. All of the parameters considered influential in evaluating the relative costs and reliabilities of the systems have been programmed into the cost model.

5.3 RESULTS OF APPLYING THE ECONOMIC ANALYSIS MODEL

The ARINC Research EAM computes annual and cumulative acquisition, installation, and logistic support costs for each concept and user

combination desired. The model was programmed to print out data for one additional year beyond the assumed retrofit period of 1987 through 2000 to evaluate the effects of new aircraft production without retrofit and of maintenance and logistics costs after fleet implementation.

This section presents the results derived from the model on the basis of the parametric inputs provided for both the discrete logic and the LSI logic transponder configurations. The costs of acquisition, installation, and recurring logistics are identified separately, by aircraft. The 15-year life-cycle costs of any of the transponder configurations an aircraft owner may expect are also presented. These costs are presented in Section 5.3.1.

The fleetwide life-cycle costs of system implementation for the 18 different transponder configurations are tabulated in Section 5.3.2. Selected configurations are presented in graphic format to illustrate the year-by-year cost of system implementation.

5.3.1 Cost of Ownership Per Aircraft

The per-aircraft cost of ownership of a DABS transponder would normally consist of the initial acquisition and installation costs for equipment configurations, a proportion of the nonrecurring logistic support costs, and the cumulative life-cycle cost of aircraft maintenance during the 15 years. These costs can be combined to provide an evaluation of the systems based on both initial investment and reliability. One cost factor (amortization of manufacturer initial costs or LSI development costs) was omitted from the cost analyses presented in this chapter because of the uncertainties regarding the effect that the competitive market would have on these costs. The results we have developed without including that factor would be comparable to costs for the transponder if the Government were to develop the LSIs and supply the design to the transponder manufacturers. The possible effects of amortization are considered in Chapter Six.

The logistic suport costs are divided into two categories: nonrecurring costs associated with introduction of a new system and recurring costs experienced from normal corrective maintenance of the system. The cost categories are:

- · On-aircraft maintenance
- · Off-aircraft maintenance
- Spare parts
- · Inventory management
- Support equipment
- · Training
- Technical data and failure documentation
- · Facilities

All categories contribute to the recurring logistics costs and all but on- and off-aircraft maintenance contribute to the nonrecurring logistics cost. For example, spare parts would normally be purchased by a repair facility and introduced into the inventory system. This would result in costs associated with the spares and the costs of inventory set-up, both considered nonrecurring. Upon failure of a unit, spares would be used and replacement spares ordered, generating a recurring cost of parts and documentation. The EAM computes such costs on the basis of the probability of failures.

The logistic support costs on a per-aircraft basis for the general aviation community, however, are limited to the recurring costs of maintenance, i.e., on- and off-aircraft maintenance costs incurred in repairing a failed unit. We do not expect the individual general aviation owner to stock either spare parts or test equipment and, consequently, to directly incur the management or facility costs associated with maintaining an inventory. The repair facility inventory maintenance costs are reflected in the general aviation cumulative life-cycle costs, however, since the EAM includes all logistic support cost categories.

The data in Table 5-1 identify the cost of ownership and the anticipated life-cycle costs for all DABS configurations for the low-performance general aviation aircraft community. The acquisition costs include the distribution costs expected in a competitive market.

Nonrecurring costs (e.g., spares inventory) on a per-aircraft basis are not identified, however, since they are considered inappropriate for the private general-aviation owner. The recurring logistics costs for each system are based on the historic low flight-hours-per-month average. The low cost of maintenance per aircraft is considered reasonable because average flight time per month is only 15.8 hours.

The data developed show the LSI version of DABS to have lower acquisition costs and slightly lower recurring maintenance costs than the discrete version. These costs are based on manufacturing quantities that justify the high development costs of LSIs.

5.3.2 Life-Cycle Cost

The per-aircraft cost identified in the preceding section are of the most importance to the aircraft owner, but the cumulative costs of system implementation (which include the total costs of acquisition, installation, and recurring and nonrecurring logistics) offer better insight into the total cost impact on the user community.

The cost-model outputs based on the data developed are shown in Table 5-2 in constant 1980 dollars and in Table 5-3 in discounted dollars. The constant year dollars (zero inflation rate) permit comparison of costs with any other life-cycle study of comparable length, regardless of the start of implementation, providing that the base costs are presented in 1980 dollars. The discounted dollars reflect a 10 percent discount rate, which is in accordance with OMB Circular A-94.

Table 5-1. COMPARISON OF (PER AIRCRAFT	P F	TRANS	SPONDER COST IN CONSTANT	AIRCRAFT TRANSPONDER COST DATA FOR LOW INSTALLATION IN CONSTANT 1980 DOLLARS)		PERFORMANCE GENERAL AVIATION	RAL AVIA	TION
SCATE	Acquisition	Inst	Installation	Recurring (Annual)	First	First Year of Ownership	Life-Cycle	ycle Cost
		New	Retrofit	Logistic	New	Retro't	New	Retrofit
		ļ	Discrete	te Version				
Basic DABS	1,303	195	264	18	1,516	1,585	1,768	1,837
Diversity	1,655	242	314	30	1,927	2,029	2,347	2,449
21.5 dBW Antenna Power	1,305	195	264	18	1,518	1,587	1,770	1,837
Comm A and B	1,342	195	264	19	1,556	1,625	1,822	1,891
Comm A and B and ATARS	1,686	195	264	18	1,899	1,968	2,151	2,220
Comm A and B, ATARS,	1,745	195	264	19	1,959	2,028	2,225	2,294
and BCAS Interface								
Comm A, B, and C	1,476	195	264	18	1,689	1,758	1,941	2,010
Comm A, B, and C and	1,820	195	264	19	2,034	2,103	2,300	2,369
ATARS								
Comm A, B, C, and D	1,793	195	264	22	2,010	2,079	2,318	2,387
			ISI	Version				
Basic DABS	1,003	195	264	17	1,215	1,284	1,453	1,522
Diversity	1,355	242	344	28	1,625	2,017	1,727	2,119
21.5 dBW Antenna Power	1,005	195	264	17	1,217	1,286	1,455	1,524
Comm A and B	1,045	195	264	17	1,257	1,326	1,495	1,564
Comm A and B and ATARS	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A and B, ATARS,	1,285	195	264	17	1,497	1,566	1,735	1,804
and BCAS Interface								
B,	1,142	195	264	16	1,353	1,422	1,577	1,646
Comm A, B, and C and	1,386	195	264	17	1,598	1,667	1,836	1,905
Comm A, B, C, and D	1,436	195	264	21	1,652	1.721	1.946	2,015

Table 5-2. LIFE-CYCLE COST FOR DABS TRANSPONDERS FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY (IN MILLIONS OF CONSTANT 1980 DOLLARS)

System	Acquisition Cost	Installation Cost	Total Logistic Cost	Total Cost
	Discrete Ve	rsion		
Basic DABS	522.7	92.6	68.8	684.3
Diversity	664.1	118.4	108.8	891.3
21.5 dBW Antenna Power	523.7	92.6	68.9	685.2
Comm A and B	538.4	92.6	69.3	700.3
Comm A and B and ATARS	676.6	92.6	69.5	838.7
Comm A and B, ATARS,	700.1	92.6	70.2	862.9
and BCAS Interface			[1 1
Comma A, B, and C	592.2	92.6	66.1	750.9
Comm A, B, and C and	730.4	92.6	70.5	893.5
ATARS				, ,
Comm A, B, C, and D	719.6	92.6	84.4	896.6
	LSI Versi	on		
Basic DABS	402.4	92.6	63.3	558.4
Diversity	543.7	118.4	103.0	765.1
21.5 dBW Antenna Power	403.4	92.6	63.4	559.4
Comm A and B	419.5	92.6	63.7	575.9
Comm A and B and ATAPS	515.5	92.6	62.3	670.4
Comm A and B, ATARS,	515.5	92.6	62.3	670.4
and BCAS Interface	ļ	j	{	(
Comm A, B, and C	458.2	92.6	60.1	610.9
Comm A, B, and C and	556.4	92.6	66.4	715.4
ATARS Comm A, B, C, and D	576.3	92.6	77.8	746.7

OMB Circular A-94 requires that life-cycle costs be discounted to reflect the opportunity cost of money. This means that money spent during a particular year has a greater impact on cost than does money spent one year later (assuming that all economic factors remain constant). The expected opportunity cost occurs because the money spent could have been invested to yield a rate of return. OMB specifies that because the expected rate of return is 10 percent, money should be discounted at 10 percent. Thus, one 1980 dollar will be worth approximately 51¢ in 1987 when the DABS acquisition begins, 15¢ when retrofit ends, and 13¢ when the life-cycle analysis is terminated.

In addition to preparing the data shown in Tables 5-2 and 5-3, we selected three DABS configurations to illustrate cumulative costs year by year. Figures 5-1 through 5-6 illustrate the LCC trends on a yearly basis

Table 5-3. LIFE-CYCLE COST FOR DABS TRANSPONDER FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY (IN MILLIONS OF DISCOUNTED DOLLARS)

System	Acquisition Cost	Installation Cost	Total Logistic Cost	Total Cost
	Discrete Ve	ersion		
Basic DABS Diversity 21.5 dBW Antenna Power Comm A and B Comm A and B and ATARS Comm A and B, ATARS, and BCAS Interface Comm A, B, and C Comm A, B, and C and ATARS Comm A, B, C, and D	152.6 193.8 152.8 157.1 197.4 204.3 172.8 213.1	27.1 34.6 27.1 27.1 27.1 27.1 27.1 27.1	16.1 25.3 16.1 16.2 16.3 16.5	195.8 253.7 196.1 200.4 240.9 247.9 215.4 256.8
Comm R, B, C, and B	LSI Vers		19.8	250.9
Basic DABS Diversity 21.5 dBW Antenna Power Comm A and B Comm A and B and ATARS Comm A and B, ATARS, and BCAS Interface Comm A, B, and C Comm A, B, and C and ATARS Comm A, B, C, and D	117.4 158.7 117.7 122.4 150.4 150.4 133.7 162.4	27.1 34.6 27.1 27.1 27.1 27.1 27.1 27.1	14.8 23.9 14.8 14.9 14.6 14.6 14.1 15.5	159.3 217.2 159.6 164.4 192.1 192.1 174.9 205.0

for the discrete and LSI versions of Comm A and B, Comm A, B, and C, and Comm A, B, and C and ATARS. These three configurations were selected as being representative of possible DABS implementations. The graphs show the trends in both constant 1980 dollars and discounted dollars.

It is evident from Table 5-2 that the primary cost associated with implementing any DABS configuration is acquisition cost. The LSI versions will cost an average of 22 percent less than the DABS discrete versions. The acquisition cost for LSI logic ranges from 18 percent less for DABS with antenna diversity to 25 percent less for DABS with Comm A and B, ATARS, and BCAS interface.

(Text continues on page 5-13.)

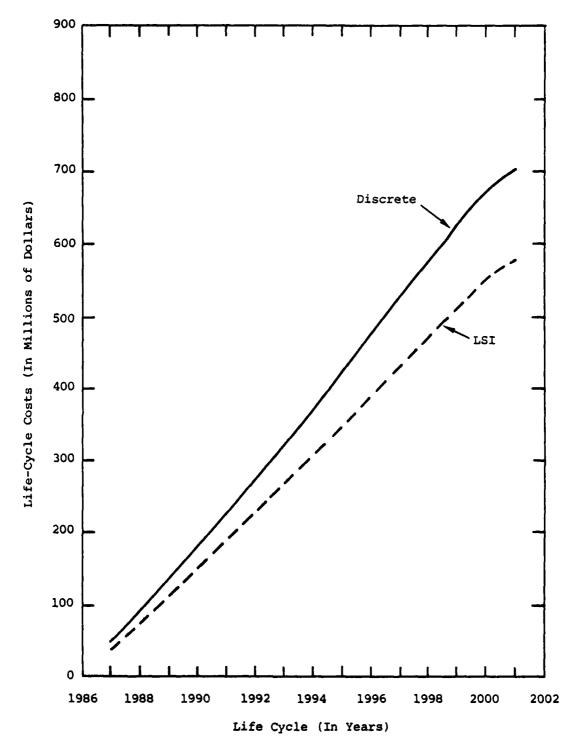


Figure 5-1. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A AND B)

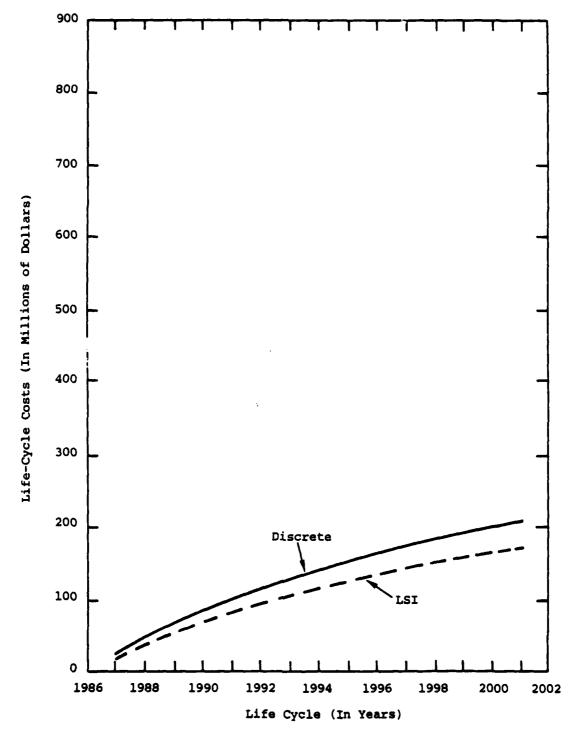


Figure 5-2. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A AND B)

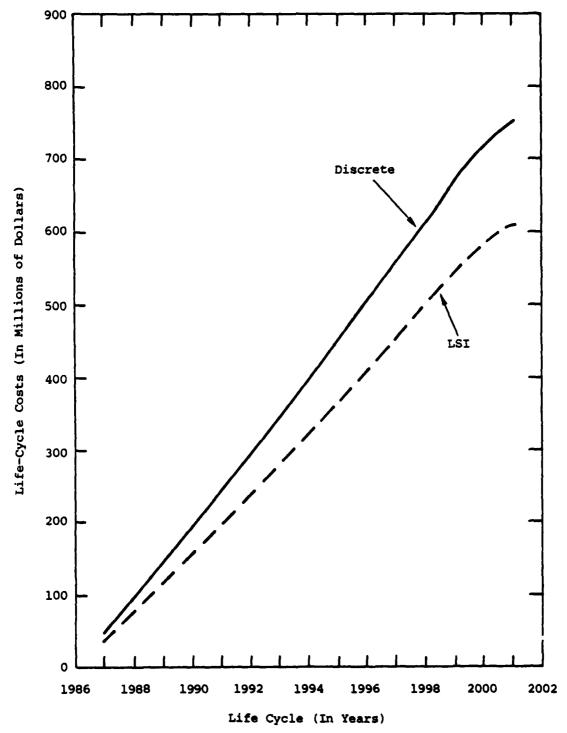


Figure 5-3. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A, B, AND C)

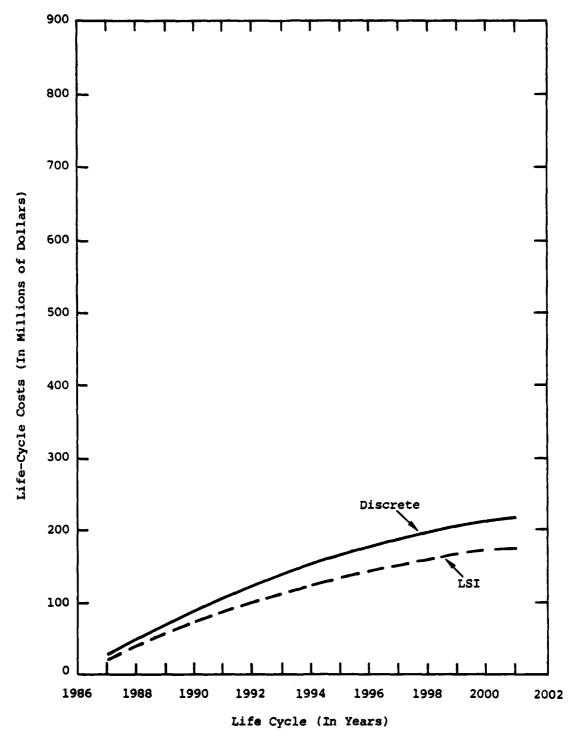


Figure 5-4. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A, B, AND C)

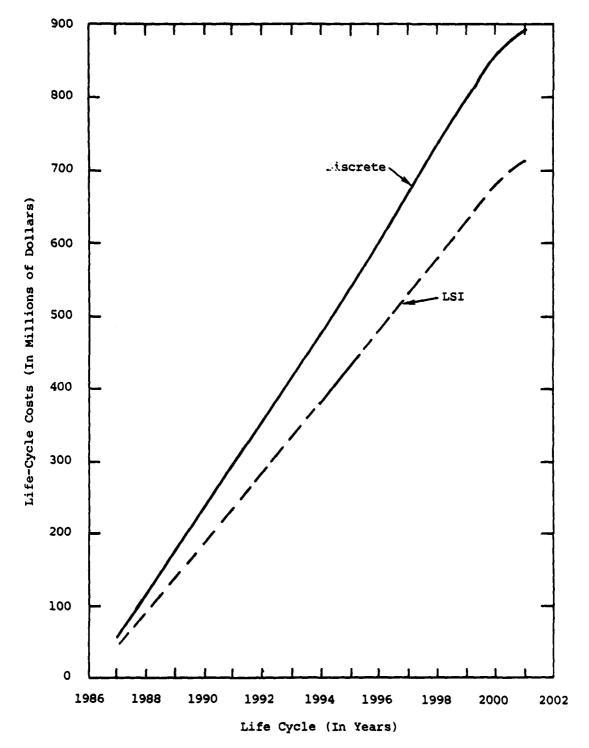


Figure 5-5. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A, B, AND C AND ATARS)

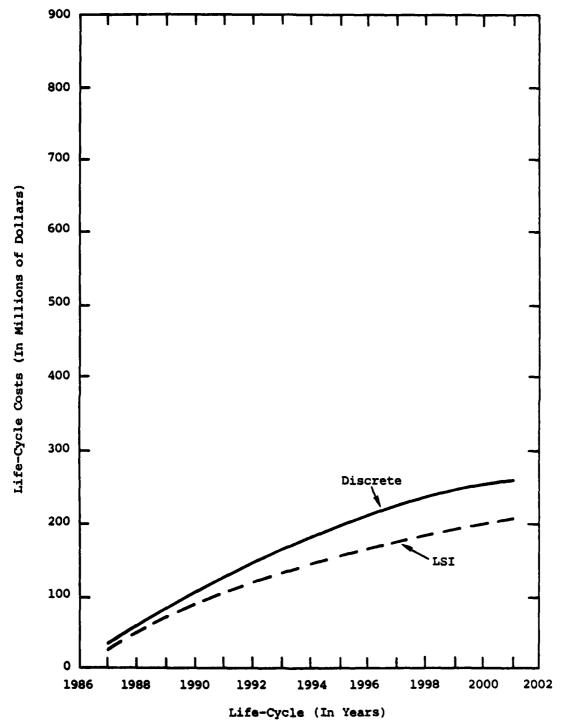


Figure 5-6. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A, B, AND C AND ATARS)

The logistic support costs are about the same for a discrete version or any LSI version except for DABS with Comm A, B, C, and D for both versions and antenna diversity for both versions.

The logistic support costs required to maintain the systems are lower for the LSI versions by approximately 8.5 percent. This overall reduction in logistic support cost required to maintain the LSI systems is due to the expected higher reliabilities associated with LSI components compared with the cumulative failures of the numerous discrete-logic components. The higher LSI reliabilities are sufficient to offset the higher material repair costs of the modules with LSIs.

The lower initial acquisition costs of the LSI configurations of the transponder, together with the lower logistic support costs, result in an average life-cycle cost 19 percent less than the cost of the discrete-logic versions. The life-cycle costs range from 14 percent less for antenna diversity to 29 percent less for Comm A and B, ATARS, and BCAS interface. The cost of the LSI version of Comm A and B, ATARS, and BCAS interface is substantially lower because all of the BCAS components are incorporated into the same LSI that includes the Comm A and B components.

Figures 5-1, 5-3, 5-5 (in constant 1980 dollars), 5-2, 5-4, and 5-6 (in discounted dollars) all show that the life-cycle costs behave similarly without regard for discrete or LSI versions or DABS capability. The differences in cumulative costs for LSI and discrete versions are a result of the differences in acquisition costs.

1 Military and by

CHAPTER SIX

SENSITIVITY OF THE DABS COST ANALYSES TO PARAMETER VARIATIONS AND ALTERNATIVE ASSUMPTIONS

In the development of data for the cost analyses of the DABS system concepts in Chapters Three and Four, assumptions had to be made regarding operational scenarios and system parameters. Because of this we reviewed the cost analyses for their sensitivity to parameter variations and alternative scenarios.

The cases considered in this review were as follows:

- · The sensitivity of life-cycle costs to variations in system MTBFs
- · The sensitivity to changes in LSI material costs
- · The effect of including LSI amortization costs in the analyses

The reasons for conducting these additional analyses and the results of the analyses are presented in the following sections.

6.1 SENSITIVITY OF LIFE-CYCLE COST TO MTBF VARIATIONS

Since the mean time between failures (MTBF) is usually difficult to predict accurately and since MTBF has a major impact on the life-cycle cost, the effect of MTBF variations on DABS life-cycle costs was evaluated. Figures 6-1 and 6-2 illustrate the effect of variations in the developed system MTBFs on the life-cycle costs predicted for the DABS configuration with Comm A and B and DABS with Comm A, B, and C and ATARS. Since the other configurations illustrated similar characteristics, they are not presented here. The figures show the system MTBFs developed in Chapter Three. A comparison of the discrete and LSI versions of the DABS transponder is also presented. Constant 1980 dollars were chosen to permit comparison with other life-cycle costs, regardless of implementation dates, on the basis of 1980 dollar costs.

Figures 6-1 and 6-2 both indicate that the life-cycle-cost estimates can be substantially affected by variations in system MTBFs. In both the discrete and LSI versions of either DABS configuration, the life-cycle costs are in the knee of the cost-versus-MTBF curve. An MTBF of 500 hours less than predicted would result in a 4 to 5 percent increase in costs for both the discrete and LSI versions of DABS with Comm A and B. An MTBF of

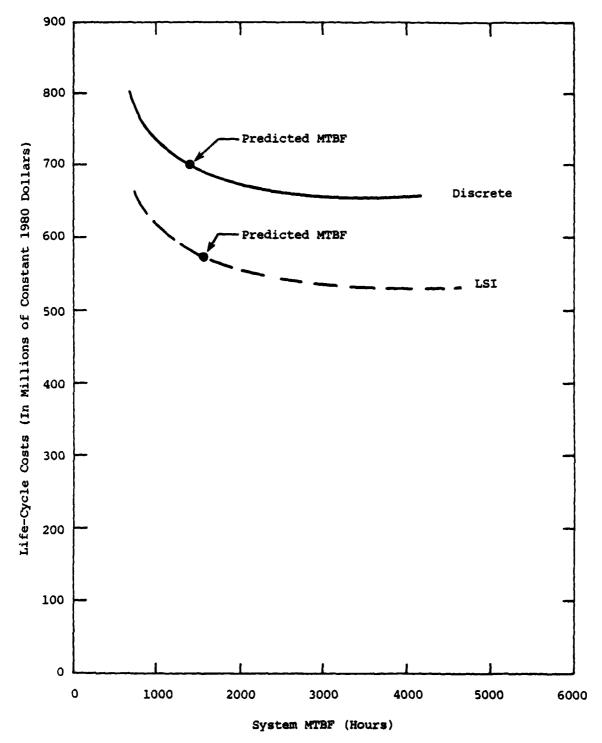


Figure 6-1. LIFE-CYCLE COSTS AS A FUNCTION OF TRANSPONDER MTBF (DABS WITH COMM A AND B)

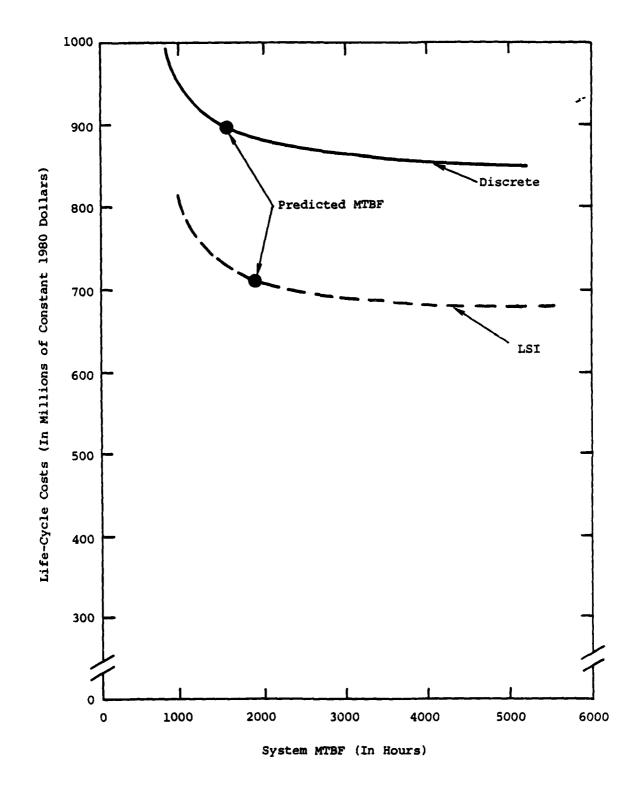


Figure 6-2. LIFE-CYCLE COSTS AS A FUNCTION OF TRANSPONDER MTBF (DABS WITH COMM A, B, AND C, AND ATARS)

500 hours more than predicted would result in a decrease in costs of approximately 2 percent. For DABS with Comm A, B, and C and ATARS, an MTBF of 500 hours less than predicted for both the discrete and LSI versions would result in a 3 percent increase in costs; an MTBF of 500 hours greater than predicted would result in a 2 percent decrease in cost for either version.

Figures 6-1 and 6-2 also provide a basis for comparing the discrete and LSI versions of a given transponder configuration to identify any MTBF variations that would make the discrete systems less costly than the LSI systems. Since the major factor in the life-cycle cost is acquisition cost, Figures 6-1 and 6-2 make clear that LSI MTBFs would require major variations to make the discrete systems more attractive than the LSI systems.

6.2 SENSITIVITY OF LIFE-CYCLE COST TO LSI AND MATERIAL COST

It is apparent from the various tables comparing discrete component and LSI transponder configurations that acquisition costs are the predominant factor in life-cycle costs. To evaluate the effect of LSI-component costs on the life-cycle cost we varied the cost of LSIs used in DABS with Comm A, B, and C and ATARS configuration from the predicted value of \$10 per LSI to \$20 per LSI and then to \$50 per LSI. This variance affected both acquisition and support costs because of the increased material cost for repair. Table 6-1 and Figure 6-3 compare the results.

Table 6-1	INCREASE IN	LIFE-CYCLE COS LSI COST (IN C ABS WITH COMM A	CONSTANT 1980	0
LSI Cost	Acquisition Cost	Installation Cost	Total Logistics Cost	Total Program Cost
10	556.4	92.6	66.4	715.4
20	608.5	92.6	66.8	768.0
50	751.3	92.6	68.1	912.0
Discrete Cost	730.4	92.6	70.5	893.5

Table 6-1 illustrates the increases in life-cycle-cost components as well as in the total life-cycle cost as the LSI costs are increased. The discrete component costs are also shown for comparative purposes. Even though the acquisition costs and the life-cycle costs using \$50 LSIs (the Table 6-1 configuration uses five LSIs) exceed those of the discrete component configuration, the total logistic costs for the LSI configuration are

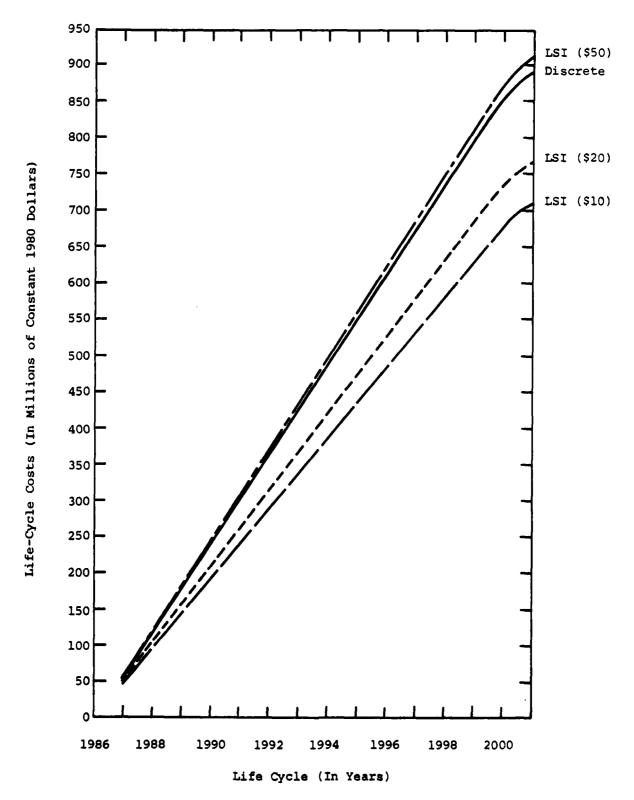


Figure 6-3. CUMULATIVE LIFE-CYCLE COST (DABS WITH COMM A, B, AND C AND ATARS)

still less than those of the discrete configuration. A linear plot of the LSI acquisition costs indicates that an LSI costing approximately \$46 would have the same acquisition costs as the discrete component version.

Figure 6-3 illustrates the cumulative life-cycle costs for the different LSI versions.

6.3 THE EFFECT OF INCLUDING AMORTIZATION OF MANUFACTURERS' LSI DEVELOPMENT COSTS

The costs associated with production start-up, tooling, engineering, and development of LSI logic are normally included in a manufacturer's selling price. However, in the review of possible ways to evaluate these amortization costs, it was recognized that a competitive market with multiple manufacturers would probably modify and reduce the normally expected amortization costs. Therefore, amortization costs were eliminated from the cost analysis in Chapter Five. Nevertheless, it was desirable to reevaluate the life-cycle costs with the effect of LSI development amortization included in order to determine if any of the cost evaluations would be altered.

The cost of LSI development was based on ARINC Research experience in other studies and information provided through informal discussion with King Radio and Bendix Aviation, both corporations with LSI development capability and experience. The costs to be amortized were taken as \$100,000 per LSI per manufacturer, with each manufacturer developing its own LSIs and amortizing the cost of development over the first two years of production.

The amortization costs that were dependent on configuration were converted into per-transponder costs on the basis of production quantities of 3,500 units per year. The resultant increased cost per unit was applied to all systems manufactured and installed during the first two years of system implementation under the assumptions that there would be several manufacturers and all manufacturers engaged in the production of the systems would have similar LSI development costs. The expected cost increase of a DABS configuration where amortization is included is shown in Table 6-2. The costs for LSI development to be amortized by the several manufacturers during the first two years of production are \$400,000 per manufacturer for a four-LSI configuration and \$500,000 per manufacturer for a five-LSI configuration.

Figures 6-4 and 6-5 present the life-cycle cost of a four-LSI configuration and a five-LSI configuration with amortization costs included. Figure 6-4 presents the four-LSI DABS with Comm A and B configuration and compares the life-cycle cost with and without LSI development cost amortization. Even though the actual life-cycle cost is approximately \$5.1 million higher with amortization included this is only a 0.89 percent increase in life-cycle cost. Figure 6-5, which illustrates the five-LSI DABS with Comm A, B, and C and ATARS configuration, is comparable to Figure 6-4. Figure 6-5 shows an increase of approximately \$6.3 million for the life-cycle cost but again this is an increase of only 0.88 percent in overall cost. These same

Table 6-2. INCREASE IN DABS CONFIGURATION COST DUE
TO AMORTIZATION OF LSI DEVELOPMENT
(FIRST TWO YEARS OF PRODUCTION)

Four-LSI Version Five-LSI Version

Cost Increase
per Transponder 57.14 (OEM) 71.43 (OEM)

LSI development costs applied to a lower life-cycle cost such as the five-LSI DABS with Comm A and B and ATARS configuration would result in an increase of 0.94 percent in the life-cycle cost. Both figures illustrate that although the cost increases in each configuration are appreciable, they are not evident when compared with the total expected expenditures. Amortization has little effect on the relative costs of the transponders because the equipment acquisition costs dominate the life-cycle costs.

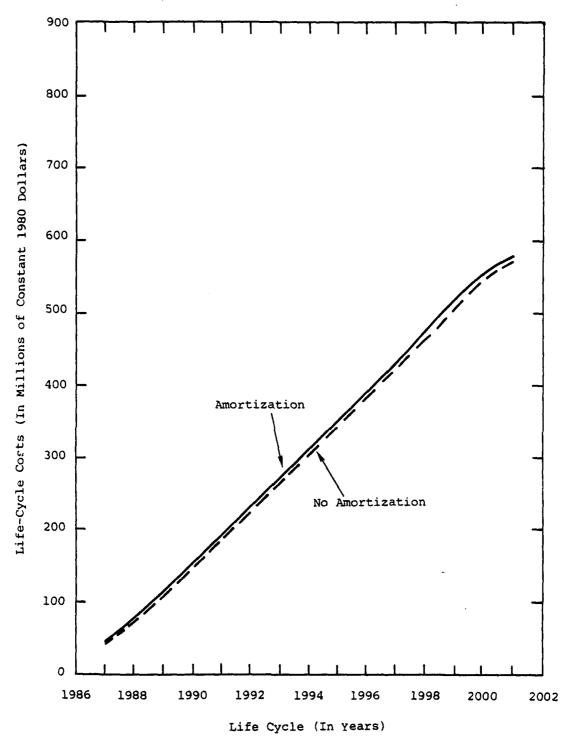


Figure 6-4. CUMULATIVE LIFE-CYCLE COST WITH AND WITHOUT LSI DEVELOPMENT AMORTIZATION (DABS WITH COMM A AND B)

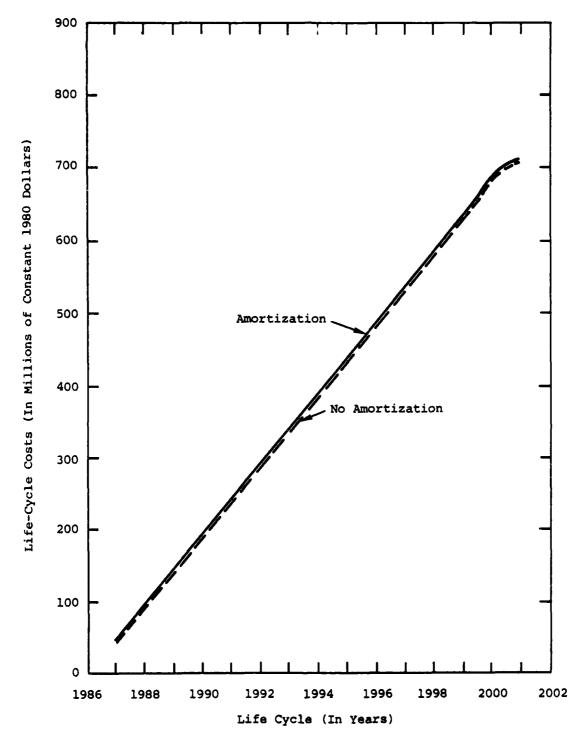


Figure 6-5. CUMULATIVE LIFE-CYCLE COST WITH AND WITHOUT LSI DEVELOPMENT AMORTIZATION (DABS WITH COMM A, B, AND C AND ATARS)

CHAPTER SEVEN

RESULTS OF EVALUATIONS

This study has developed costs of various DABS transponder configurations using both discrete and LSI components to assess the cost impact of varying levels of sophistication in a DABS transponder designed for the low-performance general aviation aircraft community (limited to single-engine and light twin-engine aircraft). Costs were also generated for an existing ATCRBS transponder (whose advertized prices are available for comparison with the study results) to lend credibility to pricing techniques used for this analysis. Calculations of DABS transponder costs were based on the accounting method of cost estimating. The transponder design data used for the cost analysis came from DABS circuit designs developed by ARINC Research Corporation. The production cost data were developed through detailed analysis of the methods of several leading avionics manufacturers producing either high- or low-performance aircraft equipment. Total system costs were evaluated with the aid of an economic analysis model. This chapter summarizes the results of the cost analyses.

7.1 COST DATA OF TRANSPONDER CONFIGURATIONS EVALUATED

The transponder costs developed during this study are summarized in Table 7-1. The values indicate the probable selling price of the transponders to the low-performance general-aviation aircraft user. Appropriate markups for distribution have been included on the basis of known or expected practices of the avionics manufacturers. All costs are based on the 1980 dollar without inflation. Potential variability in costs exists as a function of the production volume dictated by user demand. However, comparison of transponder costs based on the data presented is possible since a uniform production quantity was assumed in the evaluation of each concept.

The costs developed in this study considered various configurations of DABS transponders with both discrete and LSI logic designs. Since each configuration is unique, requiring designs that optimize the data processing for that configuration, the difference between any sets of costs in Table 7-1 should not be considered as the expected cost of later adding the particular capability. For example the cost of adding ATARS capability to an existing DABS transponder with Comm A and B capability should not be expected to be only \$430, the difference between the costs of installing DABS with and without ATARS. Rather, the cost of the DABS with ATARS can

be expected to be \$2,093 if designed originally into the system, and the cost of DABS without ATARS would be only \$1,663. The cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. Table 7-1 allows a comparative analysis of the costs associated with designing given capabilities into a transponder.

Table 7-1. ACQUISITION COST OF TRANSF (IN CONSTANT 1980 DOLLARS)		
The analog Carticulation	Compone	ents
Transponder Configuration	Discrete	LSI
ATCRBS	718	
Basic Surveillance DABS	1,614	1,239
Basic DABS with Antenna Diversity	2,054	1,679
Basic DABS with 21.5 dBW Antenna	1,617	1,242
DABS with Comm A and B	1,663	1,293
DABS with Comm A and B and ATARS	2,093	1,592
DABS with Comm A and B, ATARS, and BCAS Interface	2,167	1,592
DABS with Comm A, B, and C	1,830	1,413
DABS with Comm A, B, and C and ATARS	2,261	1,719
DABS with Comm A, F, C, and D	2,227	1,781

7.2 LIFE-CYCLE COST FOR THE USER COMMUNITY

The life-cycle costs for each transponder configuration are summarized in Tables 7-2 and 7-3. The results are presented both by aircraft and for the entire low-performance general aviation aircraft community. The unit acquisition cost shown in Table 7-2 is different from the unit acquisition cost shown in Table 7-1 because the life-cycle-cost model allows for the normal distributor discount offered when the distributor installs the avionics in the aircraft. The individual-aircraft-owner costs are likely to be of the most interest to the general aviation community, while the total user community life-cycle cost allows an evaluation of the overall cost impact of implementing any particular DABS configuration. Costs are presented for both constant 1980 dollars and discounted 1980 dollars. It is apparent from Table 7-3 that the LSI versions of DABS transponders would have a lower life-cycle cost than the discrete versions. This can be traced to their acquisition costs.

Table 7-2. COMPARISON OF (PER AIRCRAFT		TRANS TION I	PONDER COST N CONSTANT	AIRCRAFT TRANSPONDER COST DATA FOR LOW INSTALLATION IN CONSTANT 1980 DOLLARS)	1	PERFORMANCE GENERAL AVIATION	RAL AVIA	FION
Svetem	Acquisition	Inst	Installation	Recurring (Annual)	First Owr	First Year of Ownership	Life-C)	Life-Cycle Cost
		New	Retrofit	Logistic	New	Retrofit	New	Retrofit
			Discrete	e Version				
Basic DABS	1,303	195	264	18	1,516	1,585	1,768	1,837
Diversity	1,655	242	344	30	1,927	2,029	2,347	2,449
21.5 dBW Antenna Power	1,305	195	264	18	1,518	1,587	1,770	1,837
Comm A and B	1,342	195	264	19	1,556	1,625	1,822	1,891
Comm A and B and ATARS	1,686	195	264	18	1,899	1,968	2,151	2,220
Comm A and B, ATARS,	1,745	195	264	19	1,959	2,028	2,225	2,294
and BCAS Interface		·						
Comm A, B, and C	1,476	195	264	18	1,689	1,758	1,941	2,010
Comm A, B, and C and	1,820	195	264	19	2,034	2,103	2,300	2,369
ATARS			-					
Comm A, B, C, and D	1,793	195	264	22	2,010	2,079	2,318	2,387
			LSI	Version				
Basic DABS	1,003	195	264	17	1,215	1,284	1,453	1,522
Diversity	1,355	242	344	28	1,625	2,017	1,727	2,119
21.5 dBW Antenna Power	1,005	195	264	17	1,217	1,286	1,455	1,524
Comm A and B	1,045	195	264	17	1,257	1,326	1,495	1,564
Comm A and B and ATARS	1,285	195	264	17	•	1,566	1,735	1,804
Comm A and B, ATARS,	1,285	195	264	17	1,497	1,566	1,735	1,804
and BCAS Interface								,
Comm A, B, and C	1,142	195	264	16	1,353	1,422	1,577	1,646
Comm A, B, and C and	1,386	195	264	17	1,598	1,667	1,836	1,905
ATARS	,		•	6	,		,	6
Comm A, B, C, and D	1,436	195	264	71	1,652	1,721	1,946	2,015

Table 7-3. SUMMARY OF LIFE-CYCLE COSTS LOW-PERFORMANCE GENERAL AVI		
Transponder Configuration	Constant 1980 Dollars (In Millions)	
Discrete Vers	ion	
Basic Surveillance DABS	684.3	195.8
Basic DABS with Antenna Diversity	891.3	253.7
Basic DABS with 21.5 dBW at Antenna	685.2	196.1
DABS with Comm A and B	700.3	200.4
DABS with Comm A and B and ATARS	838.7	240.9
DABS with Comm A and B, ATARS, and BCAS Interface	862.9	247.9
DABS with Comm A, B, and C	750.9	215.4
DABS with Comm A, B, and C and ATARS	893.5	256.8
DABS with Comm A, B, C, and D	896.6	256.9
LSI Version	1	
Basic Surveillance DABS	558.4	159.3
Basic DABS with Antenna Diversity	765.1	217.2
Basic DABS with 21.5 dBW at Antenna	567.1	159.6
DABS with Comm A and B	575.9	164.4
DABS with Comm A and B and ATARS	670.4	192.1
DABS with Comm A and B, ATARS, and BCAS Interface	670.4	192.1
DABS with Comm A, B, and C	610.9	174.9
DABS with Comm A, B, and C and ATARS	715.4	205.0
DABS with Comm A, B, C, and D	746.7	213.5

7.3 DISCUSSION OF SENSITIVITY ANALYSIS

Major variations in the reliability data were considered to determine if there were any conditions that would cause a significant change in the relative life-cycle costs between discrete and LSI component transponder configurations. It was shown that the relative life-cycle costs are virtually unaffected by MTBF variations within the two configurations. It was shown that a 500-hour reduction in MTBF from that predicted would result in an approximate 4 percent life-cycle cost increase and a 500-hour increase would reduce life-cycle costs by 2 percent.

LSI component costs were evaluated to assess the effect an increase in assumed LSI cost would have on the life-cycle costs. It was determined that for the scenarios used the LSI component cost would have to increase by more than 350 percent (from \$10 to \$46) before the LSI life-cycle acquisition costs would equal the discrete component acquisition costs. Even then the required LSI logistic support costs would be less than those for the discrete component configuration.

Amortization of LSI development costs was analyzed to determine the effect of the Government sponsoring LSI development (no amortization costs) as opposed to the avionics manufacturing community developing LSIs in the competitive market. It was determined that the effect of the manufacturers developing LSIs on their own was negligible over the life cycle. Private development of LSI added approximately 0.89 percent to the total lifecycle costs with full amortization taking place over the first two years of production. For the individual owner buying transponders during the first two years of implementation this translates into an approximate \$114 increase in transponder list price for a configuration requiring four LSIs and a \$142 increase in list price for a transponder configuration requiring five LSIs.

7.4 RELATION OF THE DABS COST ANALYSIS TO THE IMPLEMENTATION OF A NATIONAL DABS SYSTEM

This study has been concerned with the cost evaluation of the airborne portion of the DABS concept; it has not addressed other key issues that will most likely affect the development and implementation of a national DABS system. For example, the operability of the system has not been evaluated and there has been no human-engineering evaluation of an integrated display. A change in the presentation of data on the display or going to a separate display unit could have a major effect on the costs presented in this study.

In addition, the analyses and conclusions reported herein have been based on the assumption that all aircraft will install DABS equipment. However, if there is a significant change from this policy, so that only a portion of the total aviation community chooses to be DABS-equipped, or the time of implementation is extended well beyond the 14-year retrofit period assumed, then the costs of the DABS components will increase, because they are controlled by the production quantities required to meet the new demand for equipment.

While there are many factors such as the above that must be considered by the FAA, we believe the cost analysis of all levels of DABS sophistication will be key elements in the ultimate selection of a minimum operational DABS configuration.

APPENDIX A

SYSTEM PARTS LIST AND COST-DEVELOPMENT DATA SHEETS

This appendix contains the work-sheets used to develop costs of modules and systems employed in the various DABS configurations. These costs were the basis for the calculations presented in Chapter Three of this report. The sheets are grouped by system configuration in the 19 sections of this appendix.

	DISCRETE DABS CONFIGURATIONS	Page
A-1	ATCRBS · · · · · · · · · · · · · · · · · · ·	A-3
A-2	BASIC DABS	A-11
A-3	BASIC DABS with Antenna Diversity	A-21
A-4	BASIC DABS with 21.5 dBW at Antenna	A-31
A-5	DABS with Comm A and B	A-41
A-6	DABS with Comm A and B and ATARS	A-51
A-7	DABS with Comm A and B, ATARS and BCAS Interface	A-63
A-8	DABS with Comm A, B, and C	A-75
A-9	DABS with Comm A, B, and C and ATARS	A-85
A-10	DABS with Comm A, B, C, and D	A-97
Ľ	SI DABS CONFIGURATIONS	
A-11	BASIC DABS	A-109
A-12		
A-13	_	
A-14		
A-15		
A-16		A-159
A-17		
A-18		
A-19		

APPENDIX A-1

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM TRANSPONDER
(ATCRBS)

SYSTEM GENERAL AVIATION TRANSPONDER

SUB-ASSEMBLY RECRIVER

ITEM MANE OR	חנג	UNIT	LOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY * FAIL. BATE
		3	1600	MANUFACTURING	KTEKESSY	RATE	RATE	X UNIT COST
P.C. BOMED	1	4.00	4.00	818	25	,	•	
CD 6585	4	88	88		S	.155	.155	40.
FF 1100	1	.63	.53		\$.155	351.	.082
19 916	1	.05	.05		S	. 361	.361	910
2N 5133	9	ct.	. 39		18	1.266	3.798	164.
2M 5138	3	.12	. 36		18	1.266	3.798	.456
CAPACITOR	-	91	.57		15	. 160	087	160.
CAPACITOR-DISC	29	.13	3.77		145	.629	19.241	2.371
RESISTOR	37	.03	1.11		185	.013	.481	10.
RESISTOR-VAR.	3	.35	1.05		45	3.242	9.726	3.404
TRAMETSTOR	4	.24	1.44		36	965.	3.576	.659
INDICTOR	1	.35	.35		5	.475	.475	.166
7103	4	21.	97		24	690'	376	.033
CHOKE	2	91.	36.		20	2.120	4.240	.763
TRANSFORMER, NO	-	1.35	1.35		40	8.938	96.6.8	12.066
Christal	-	8.0	8.00		15	1.500	1.500	12.000
MTCS-HABINARE	101	S.	. 50		50	•	_	
SR'T-HETAL	5	2.00	2.00	167	50	•	•	
TOTALS			26.79	586	706 x 1.5 (1059)		56.200	32.690 (\$2.63)

SYSTEM G.A. Transponder

PAR.
GRACE
C.
MAIN
SUB-ASSIDELY

1	ITEN NAME OR	Q1,	TIM	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY x PAIL. PATE
1, 129			3	3	HANDFACTURING	ASSEMBLY	FAILURE	FATLURE RATE	x UNIT COST
1 1.09 1.99	P.C. BOARD	4	6.00	6.00	818				
1	319	4	1.29	1.99		5	.715	.715	1 423
1 1.26 1.26 5 1.05	555	7	,85	.85		5	.115	.715	.607
1 1.05 1.05 5 1.05	7404	-	.26	.26		ıc	.035	.035	600
1 1.05 1.05 5 .715 1.05	7494	-	1.29	5.16		20	.715	2.860	3.689
1	7005	1	1.05	1.05		5	.715	.715	.751
Q 2 24 48 10 120 2 4 24 96 20 120 3 1 31 31 5 715 4 1 31 3.39 15 715 21 3 1.13 3.39 15 715 2 1 3 1.39 15 35 .160 16 16 16 16 16 16 16 16 16 16 16 16 16 16 16 17 17 17 17 16 16 16 17 16 16 17 16 16 16 17 16 16 17 <th>74121</th> <td>1</td> <td>R.</td> <td>131</td> <td></td> <td>S</td> <td>.715</td> <td>317.</td> <td>. 222</td>	74121	1	R.	131		S	.715	317.	. 222
2 4 .24 .96 20 .120 3 1 31 .31 .31 5 .715 4 1 .31 .31 .31 .315 .715 .715 21 3 1.13 3.39 15 .715 .715 .715 21 3 1.33 3.38 130 .150 .160 .160 .160 .160 .160 .160 .160 .160 .160 .160 .174 .175 .2	741.500	7	-24	- 48		10	.120	240	920
3 1 31 5 715 2 1 11 31 339 15 715 2 11 3 1.33 1.33 35 1.15 7.15 2 1TOR DISC 26 .13 3.38 130 .160 .160 .160 .160 .160 .170 .160 .170 .1	741.502	b	124	%		20	.120	480	211
4 1 31 5 715 2 21 3 1.13 3.39 15 715 2 TOR 7 19 1.33 35 160 1 ITOR VAR 1 31 3.18 130 629 8 ITOR VAR 1 31 3.18 10 629 8 TOR METIC 13 2.55 10 10 0.65 10 TOR METIC 13 1.6 2.08 65 0.046 22 TOR VAR 3 2.45 105 3.242 2.2 ISTOR WER 4 3 4.90 70 155 2 S 4.90 70 1.55 2	741.573	1	11.	.31		5	.715	27.5	.222
21 3 1.13 3.39 15 7.15 2 ITOR DISC 26 .13 3.38 130 .629 16 ITOR VAR 1 .31 .31 15 8.599 8 TOR MET'L 13 2.55 .50 10 .065 10 TOR MET'L 13 .16 2.08 65 .046 2 TOR VAR 7 .35 2.45 105 3.242 2 ISTOR NUM 4 .140 60 .270 2 ISTOR NUM 4 .35 4.90 70 .155 2 S 14 .35 4.90 70 .155 2	741874	1	181	.31		\$.715	.115	.082
TYOR DISC 26 1.33 35 .160 TYOR DISC 26 .13 3.38 130 .629 1 TOR VAR 1 .31 .31 15 8.599 1 F-WIRE WD 2 .25 .50 10 .065 .013 TOR WELL 13 .16 2.08 65 .046 .065 TOR VAR 7 .35 2.45 105 .270 .270 STOR WEN 4 .14 .56 24 .316 .316 SS 4.90 .70 .155	7415221		1.13	3.39		15	.715	2.145	2,424
ITOR DISC 26 .13 3.38 130 .629 1 ITOR VAR 1 .31 .31 .31 .15 8.599 .013 TOR 65 .03 2.55 .50 10 .065 .013 PR-VIRE ND 2 .25 .50 10 .065 .046 <t< th=""><th>CAPACITOR</th><td>7</td><td>61.</td><td>1.33</td><td></td><td>35</td><td>. 160</td><td>1.120</td><td>.213</td></t<>	CAPACITOR	7	61.	1.33		35	. 160	1.120	.213
ITOR VAR 1 31 31 11 15 6.599 6 FUNIE WD 2 .25 .55 .013 .1 F-VIRE WD 2 .25 .50 10 .065 TOR WET'L 13 .16 2.08 65 .046 .2 TOR VAR 7 .35 2.45 105 3.242 2 ISTOR PAR 10 .14 1.40 60 .270 2 ISTOR REM 4 .36 .316 1 A .35 4.90 70 .155 2	CAPACITOR DISC	26	.13	3.38		130	629	16.354	2.126
TOR 65 .03 2.55 425 .013 1 R-WIRE WD 2 .25 .50 10 .065 .065 TOR WART 7 .35 2.45 105 1.242 22 ISTOR RWH 4 .140 60 .270 2 ISTOR RWH 4 .35 4.90 .70 .155 2 S 3 4.90 70 .155 2	CAPACITOR VAR	-	.31	.31		15	8.599	8.599	2.666
Paymer wd 2 25 50 10 .065 TOR MET'L 13 .16 2.08 65 .046 22 TOR VAR 7 .35 2.45 105 3.242 22 ISTOR PMP 10 .140 60 .270 2 ISTOR REM 4 .36 .316 1 8 14 .35 4.90 70 .155 2	RESISTOR	85	:03	2.55		425	.013	1.105	.033
TOR MET*L 13 16 2.08 65 .046 TOR VAR 7 .35 2.45 105 3.242 22 ISTOR NPM 10 .14 1.40 60 .270 2 ISTOR NPM 4 .35 4.90 70 .155 2 S 3 4.90 70 .155 2	RESISTOR-WIRE WD	2	-25	.50		10	.065	.130	.033
15TOR PNP 10 .14 1.40 60 .270 LSTOR NPN 4 .14 .56 24 .316 S 4.90 70 .155	RESISTOR MET'L	13	.16	2.08		65	.046	.598	960.
STOR NPM 10 .14 1.40 60 .270 .	RESISTOR VAR	7	35	2.45		105	3.242	22.694	7.943
STOR UPN 4 .14 .56 .24 .316 .316 .316 .316 .316 .316 .318 .318 .318 .318 .318 .318 .318 .318	TRANSISTOR PNP	10	14	1.40		9	.270	2.700	. 378
3 4.90 70 .155	TRANSISTOR IRM	4	4	95.		2.4	.316	1.264	117
	D100E	14	35	4.90		70	.155	2.170	. 760
	TOTALS								

SYSTEM G.A. Transponder

-
1
V MATER V
SIB-ASSPHRIV

ITEM NAME OR CATEGORY	OT.	COST	TOLYT	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	107AL	QTY * FAIL. RATE
		3	3	HANUFACTURING	ASSEMBLY	FAILURE	FALLURE	x UNIT COST
CHOKE	•	. 18	51.		40	212	070	
TRANSPORMER-PCH	7	8.12	8.12		316			Ect.
						7.200	1.500	12.180
TUTALS			49.37	818	1294		69.132	36, 359

SHEET 4 OF 5

SYSTEM G. A TRANSBOADER SUB-KSSEMBLY CUASSIS

ITEM NAME OR	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY * FAIL. RATE
. wooding		1893	Teon	HANUFACTURING	ASSEMBLY	FAILURE	FATLURE	x UNIT COST
FRONT PANEL	1			74	22	,		,
NOTTON COVER	1			48	20	٠		
TOP COVER	-	15.00	15.00	17	22	,		-
REAR PANEL	-			184	20	,		•
SIDE PANEL	7			234	32		_	-
PANEL P.C. BOARD	-	6.60	. 09.9		100			
PUSH BUTTON SW	-	.50	.50		25	18.596	18.596	9.298
LAMP	4	.62	2.48		100	25.856	103.424	64.123
TRANS CAVITY	-	30.00	30.00		225	200.00	200.000	6000.00
PRESELECTOR	4	7.50	7.50		50	1.180	1.180	8.850
LOW PASS FILTER	1	3.00	3.00		25	11.844	11.844	35.532
HISC-HARDWARE	101	2.50	2.50		100	,	,	_
MATERIAL	101	4.00	4.00		200	1		
TOTALS			69.72	581	941		335.044	6117.803 (\$82.17)

SYSTEM G.A. TRANSPONDER SUB-ASSEMBLY ASSLY F. TEST

ITEM NAME OR	OTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	GTY × FAIL. RATE
			1883	HANUFACTURING	ASSEMBLY	RATE	RATE	X UNIT COST
P.C. BOARD	1				20		,	_
FRONT PANEL	1				05	,	-	
CAVITY	1				25	,	,	•
RECEIVER	1				25			,
AL IGNHENT	-				250	,		-
BURN-IN	,				200	,	,	-
TEST	,				1000	'		
TOTALS					1900			

AD-A112 957

ARINC RESEARCH CORP ANNAPOLIS MD

COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW-ETC(U)

SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-3788

UNCLASSIFIED

2 or 4

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

41.2

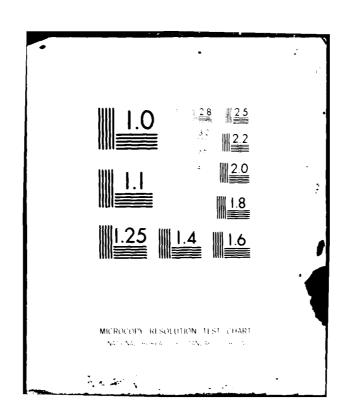
41.2

41.2

41.2

41.2

41.2



APPENDIX A-2

BASIC DABS
(Discrete Version)

SHEET 1 OF 8

SYSTEM DABS Transponder

SIM-ASSEMBLY IF AMPLIFIER

ITEM NAME OF	01V	TIMI	TOTAL.	LAINUR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV = PAIL. RATE
			900	HANDFACTURING	ASSEMBLY	PATE	RATE	
7416	7	88.	.88		9	. 786	. 786	269°
74121	1	18:	.31		6	. 786	. 786	.244
18277	7	,36	. 36		5	. 715	.715	.257
114151	3	. 30	06.		15	.150	.450	.135
114743	7	.20	.20		5	. 786	. 786	.157
2115.086	-	71.	.11		19	2.124	6.372	. 361
MP86515	1	.43	.43		Q	. 316	.316	.136
MPSH10	1	.33	.3.		9	.316	. 316	. 104
SPS6797	8	97.	6.24		48	315	5.720	4.462
5082-2835	-	36	38		5	.715	.75	2.72
TSTR. 81	1	14.			9	316.	. 316	061.
DIODE. SI	1	32	27		5	.155	.155	050,
CAP. STO.	4	.93	3.72		18	629	2,516	2.340
CAP. CER.	2	92	.72		10	. 160	. 320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	. 41	1,23		15	. 550	1.650	929.
RESISTOR NC	79	.03	1.92		320	.013	.032	.025
CHOKE	9	.36	2.16		36	2.120	12.720	4.579
COIL	2	.12	.60		30	.069	. 345	.041
COIL NE	~	. 28	.56		12	.475	.950	. 266
CRYSTAL	-	8.00	9.00		15	1.500	1,500	12.000
FILTER	-	.28	. 28		ø	5.127	5.127	1.4%
TOTALS								

SYSTEM DABS Transponder

SHEET 2 OF 8

SUR-ASSEMBLY IZ AMPLITIEE (Cent'd)

ITEM MANG ON CATEGORY	QTT	CANT	TOTAL	LAPOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	107AL	OTY × FALL. MATE.
		T S C C	ust	HAMUFACTURING	ASSEMBLY	FAILURE	FALLURE	× UNIT CRET
TRANSF	9	9K .	2.28		40	2.309	13.854	\$ 366
PC Board	7	4.00	4.00	818	25	•		
MISC. HOW.	101	,50	.50		50		'	
SHT. MC.	101	1.50	1.50	167	50			
TOTALS			44.25	586	987 x 1.5 (1461)		70.342	35.245

SYSTEM DABS Transponder

SUB-ASSEMBLY DESK DEMOD./PPM MOD.

ITEM NAME OR	A.E.	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIHO	TOTAL	OTY x FALL. HATE
CATEGORI		008T	COST	HANDFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7404	-	92.	. 26		80	.715	\$11.	. 186
7408	1	.26	. 26		8	.120	.120	160.
7478	1	.31	.31		8	.715	.715	. 222
74121	4	T.	.33		88	.115	2115	222
74132	-	19.	.64		8	.120	.120	220.
67121		1.24	1.24		9	.715	317.	.867
2N3646	1	.68	.68		9	. 316	. 316	215.
MPSAS6	2	-11	.34		12	316	612	701
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	. 23	.23		15	0.599	8,599	1.978
RESISTOR FC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOD	1	5.00	5.00		50	,715	.715	3,575
POTENTIONETER	1	.42	.42		15	. 664	.664	.279
PC Board	1	2.00	2.00	818	25	-	_	_
HISC. HOW	101	. 50	05.		50	_	1	
TOTALS			14.35	918	32894) 1.5		18.462	12.53,

TETTA DABS TRANSPONDER

SIT--ASSPORLY POWER SUPPLY

CATEGORY	λ.	TIRS	TOTAL.	LANUR HOURS PUR 1000 UNITS	1000 UNITS	URIT	JOTAL	OT * FAIL. HATE
		3	T G	MARIN'ACTURING	ASSEMBLY	FALUNE	FATURE EXTE	x Unit ast
MJE200	2	.57	1.14		16	1.970	2 040	
MJE1100	2	1.33	2.66		16	1 930		
IN4733A	-	,20	.20			0/2:-	3.940	5,240
IN4735A	1	. 20	.20				786	.157
T04742A	1	92.	.20		-	786	786	152
TN\$2298	-	2.	.15		-	. 786	786	751,
2H7222A	-	99	4			8	786	.110
SFH 30	2	\$	1.60		9	376	316	126
TESTR. SI	-	. 15	15		01	- 155	310	248
DIODE, SI	2	35	20		9	316	316	247
RESISTOR FC.	=	.03			O. S.	.155	310	109
RES ISTOR MF	2	22	7.4		66		- 143	700
COIL	•	-12	48	-	07	042	8.	270
CAP AL.	-	18.	2.52		24	.069	. 276	.031
CAP DC	107		96.		AT.	.629	1.887	1.565
TRAMSFORMER		2.44	2.44		20	291	2.910	378
POTENTIOMETER	2	8.	1 69	1	0.0	8.998	8,998	21.955
PC. BOARD	-	2.00	2 00		30	.664	1,328	1.116
2017				919	25	-		
niot. mw.	53	કો	.50		50		1	
SHT HTL.	5	8	. 50	167	50			
		Ì						
TOTALS			19.89	985	436 x 1.5 (654)		27.64	33.721 (\$5.49)

SYSTEM Baseline DABS Transponder SUB-ASSEMBLY Decoder/Encoder

ITEM MANE OR CATEGORY	A.C.	TIND	TUTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
			1800	HANUFAC'TURING	ASSEMBLY	FATLURE	FALUNE RATE	x UNIT COST
7400	2	.24	. 8₽.		16	120	240	
7402		,24	.72		24	5.		960.
7404	10	.26	2.60		9	23.5	701	980
7407	-	a	ca		8	64/;	7.150	1.859
2408	۶		7		20	\$17.	3115	.229
200	3,	\$	5.20		160	120	2.400	624
1432	-	.26	1.82		56	.120	.840	. 218
7478	6	17.	2.79		717	.715	6 435	1 905
7485	6	-84	7.56		7.2	715	36.7	*****
7486	9	.55	3.30		48	220	220	5005
7491A		. 92	2.76		24	715	2 2 2 2	8
74138	1	.65	\$9:		•	316		1.973
74150	1	.97	.97		2	715	- (113	-465
74153	2	.72	1.44		14	31.5	24/	, 694
74154	1	1.07	1.07		13	316	1.430	1.030
74157	8	21.	5.76		90	315	en,	765
74161	6	.54	4.86		9	23.5	02/16	4.U°
74164	,	.93	6.51		3,5		6.435	3.475
74166	25	.93	23.25		250	715	2,002	4.655
74174	2	61.	1.58		20	316	6/8/7	10.204
74198		7	cr 3		*		1.430	1.130
747.001			37.75		48	.715	2.860	4.090
11811	1	-24	1.68		56	.060	.420	101
745271	4	1.29	1.29		12	715	215	033
TOTALS								
ĭ	_		_					

SHEET 6 OF 8

SYSTEM Baseline DABS Transponder

SUD-ASSEMBLY Decoder/Encoder

				and purious access		-		
CATEGORY	5	1300	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	2011	מלוויו איניין	will a rail. KATE
CALEGORIE				MANUFACTURING	ASSEMBLY	RATE	RATE	
MC 8504P	9	5.75	34.50		48	211.	4.290	24.668
DM 75529	•	1.29	5.16		32	.715	2.860	3.689
NC 556	2	.85	1.70		10	317.	1.430	1.216
TRSTR NPN	g	971	- 84		36	.316	1.896	. 265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10,00	10.00		15	1.500	1.500	15.000
CAP Disc	10	.13	1.30		50	.291	2.910	976.
PC Board	2	10.00	20.00	1776	100	,	1	4
Misc. Hdw.	Lot	.50	.50		50			
TOTALS			158.97	1776	2054 x 2 (4108)		87,505	95.802 (4.93)

SHEET 7 OF 8

SYSTEM Beseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEN NAME OR	710	1140	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × PAIL. RATE
		1001		HAMUFACTURING	ASSEMBLY	FAILURE RATE	FAI LURE NATE	* UNIT COST
PROSIT PASEL	1			74	22			
CHASELS	~			184	*		,	
TOP COVER	-	15.00	15.00	41	22	•		•
MOUNT	1			164	20			•
BOTTON COVER	1			48	20		-	
PANEL PC BOARD	7	5.00	5.00	818	700			
CAVITY	1	30.00	30.00		225	200.000	200.000	6000, 000
PRESELECTOR	-	7.50	7.50		50	1.16	1.180	8.850
L.P. PILTER	-	3.00	3.00		25	11.844	11.844	15.512
POTENTIONETER	7	.35	.35		15	.664	999	213
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9 200
NOTARY SHITCH	-	1.68	1.68		100	4.415	4.415	7.417
LANP	_	.62	4.34		100	25.856	180.992	112.215
24 PIN COMMECTOR	R 2	.95	1.90		50	1.120	2.256	2.143
MISC. HDW.	101	2.00	2.00		100			
SH'T MRTAL	LOT	3.00	3.00		200			
RP COMMECTOR	-	1.23	1.23		15			
FLEX CABLING	103	5.00	5.00		500			-
CODE SWITCH	+	1.00	4.00		100	2.395	9.580	9.560
PC Connectors	8	1.26	6.30		75	,		
TOTALS			90.80	1349	1808		429.527	6185.267 (64.80)

HEET 8 OF B

-ASSEMBLY ASSY, 6 Test

ITEM MASS OR	E	1185	"YOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
CATEGORIE		CUST	COST.	HANUFACTURING	ASSEMBLY	PATE	RATE	ign) itan v
If Amp	1				\$0			
Mod/Demod	1				\$0			
Per Supply	1				150			
Enc/Dec 81	1				25			
Enc/Dec 82	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	lot				25			
Alignment					500			
Burn-In					500			
Test	•				1000			
TOTALS					2550			

APPENDIX A-3

BASIC DABS WITH ANTENNA DIVERSITY (Discrete Version)

SHEET 1 OF 8

SYSTEM DABS Transponder SUB-ASSEMBLY AF ABOLITIEL

ITEM NAME OR CATEGORY	OTY.	COST	TOTAL.	LANOR WOURS PER 1000 UNITS	1000 UNITS	טמוד	TOTAL	QTY K PAIL. RATE
				HANUFACTURING	ASSEMBLY	FATCURE	FAILURE RATE	x UNIT COST
2416	-	.08	. 88		•	786	705	
74121	7	.31	.31			7.06	305	260:
IN277	-	.36	. 36		5	715	215	250
IMISI	-	.30	6 .		15	150	450	301
IN4743	4	.20	. 20		5	786	786	16.3
2N5086	7	717	711		18	2.124	6.372	161
NPS6515	4	.43	.43		9	.316	.316	. 136
MPSII10	-	.33	.33		9	.316	.316	104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		5	.715	.75	2.73
TSTR. SI	7	4	14.		9	.316	.316	01.1
DIODE: \$1	7	22.	. 32		5	.155	.155	050
CAP. STO.	4	.93	3.72		18	.629	2.516	3 340
CAP. CER.	7	.36	.72		10	.160	320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	7	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	9	. 36	2.16		36	2.120	12.720	4.579
7100	2	.12	.60		30	690.	. 345	.041
COIL RF	2	.28	.56		12	.475	. 950	. 266
CRYSTAL	7	9.00	8.00		15	1.500	1, 500	12.000
FILTER	-	.28	.28		9	5.127	5.127	1.436
TUTALS								

SHEET 2 OF 8

SYSTEM DABS Transponder

SUR-ASSEMBLY IF AMPLIFIER (Cont'd)

ITEM NAME OR	QTY	TIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	QTY × FAIL. RATE
		- GO	9	PANUFACTURING	ASSENBLY	PATE PATE	FALLURE	X UNIT CIST
TRANSF	9	. 38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	_		
MISC. Hdw.	LOT	,50	.50		50	-	ı	•
SHT. MTC.	TOT	1,50	1,50	167	50	,	•	•
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DASS Transponder

848-ASSEMBLY DESK Demod./PPM. Mod. & Diversity Switch

5

SHEET 3

ITEN NAME OR CATEGORY	QTA	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	TOTAL	OTY * PAIL. RATE
			3	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7404	~	. 26	.26		9	715	315	
7408	7	.26	.52		16	120	CTV:	. 186
2420	-	,31	. 31		œ	715		790
74121	~	.31	63		,		- (1)	
74132	-	:			10	.715	1.430	.443
26.167	1	50	.64		8	.120	120	7.00
2116	7	1.24	2.48		77	-715	1.430	1,773
758287	4	गा	1.10		9	.316	316	348
2N3646	7	99:	1,36		12	.316	613	919
2H3066	7	1.24	1.24		9	316	316	200
HP2000	2	77	G . B4		.2	155		266.
14316H	4	2,10	2,10		80	3,5	216	001
MPSA 56	*	.17	89.		24	31		1.502
CAP DISC	34	.13	4.42		170	201	1.694	-2115
CAP VAR	7	.23	21			1625	7.074	1.296
RESISTOR, FC	40	.03	1.20		200	8.292	0.599	1.978
COIL	•	.28	1.12		24	600	075	910.
PHASE LOCK LOOF	1	00.5	8 4			co.	9/7:	.077
POTENTIONETER	,	,			OC.	- 113	-,715	1,575
3		75.	184		30	1664	1.328	.557
re- Bound	1	5.00	2.00	818	25		-	•
MISC. HDW.	101	.50	.50		50	•	•	
	1							
TOTALS			27.46	818	7900\$0}.5		29.535	13,269 (2.02)
					-		_	

SHEET 4 OF 8

SYSTIA DABS TRANSPONDER

· .

SO THE ASSIDINATION POWER SUPPLY

ITIH HAME OR CATEGORY	QTY	1980	Tratal.	LAMOR LAYING BYR 1000 URITS	มกคด ปลเาร	TIM	TOTAL	2TY # FAIL. MATT
		3		IM: UFACTURERS	ATHKESSY	FATUME	rature Rate	N UNIT CAL
M.1E200	2	.57	1.14		16	1.970	3.940	3 246
NJE1100	2	1.33	2.66		16	1.970	3 040	3,5
IN4733A	1	,20	. 20			À	OME :	3,440
IN4735A	1	. 20	. 20			g yer	786	761
IN4742A	1	.20	. 20			196	786	751
IN\$229 6	1	-115	.15		5	705	786	751
2N7222A	-	.40	100			8	98/	.118
SEM 30	2	8.	1.60		9	917	916	126
TRSTR, 81	-	.15	. 15		77	155	910	248
D100E, S1	2	36.	2.			316	316	047
RESISTOR PC.	11	.03	.33		10	.155	310	109
RESISTOR HE	~	:	1		23		- 01.	700
COIL					10	282	¥80.	240
TA DAY		31	#		24	.069	,276	100.
Cas or	,	5	7.37		18	.629	1.687	1,585
	2	1.1	1.30		50	.291	2.910	178
TRANSPONER	-	2.44	2.44	}	40	8.998	8.998	21 955
POTENTIONETER	~	.84	1.68	1	30	. 664	1.328	1 116
rc. BUARD	-	2.00	2.00	818	25		;	
MISC. HIM.	1 03	8	50		20			
SHT MTL.	FO3	.50	.50	167	50			
		-						
TOTALS			19.69	596	436 x 1.5 (654)		27.64	33, 721 (\$5.49)
					•			

SHEET 5 OF B

SYSTEM Baseline DABS Transponder

		}					SHEET	e o
Still-Assembly Deco	Decoder/Encoder	EE						
ITEM NAME OR	OTV	TIMI	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIND	TOTAL	QTY × FAIL. RI
		9	Ten	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	* UNIT COST
7400	2	.24	.48		16	.120	240	0,00
7402	1	.24	.72		24	120		960
7404	10	,26	2.60		90	115	200	980
7407	1	. 32	. 32		œ	316	Acr.,	658.1
7408	20	32.	5.20		16.0	1.30	500.	223
7432	,	. 26	1.82		26	.120	840	624
7478	6	u.	2.79		11.7	316		917
7465	6	10.	7.56		72	316	6.435	1,975
7486	9	.55	3.30		69	130	25	5.405
749LA	1	. 92	2.76		24	.715	2 145	136
74136	1	.65	.65		•	235	31.5	6/6:1
74150	1	.97	.97		01	31.5	517	505.
74153	2	.72	1.4		16	316	car,	769
74154	1	1.07	1.07		1.2	31.5	1.430	1.030
74157	•	и.	5.76		8	7115	27.0	265
74161	6	.54	4.86		8	71.5	6 435	9119
74164	7	.93	6.51		56	.715	5.005	1 656
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	62.	1.59		20	.715	1.430	9.1
74196	•	1.43	5.72		46	.715	2.860	380
741621	1	.24	1,68		56	090	420	101
748271	1	1.29	1.29		12	715	715	
TOTALS								
	_	_	_					

SYSTEM Baseline DABS Transponder

SUR-ASSPORTY Decoder/Encoder

ITEM NAME OR	QTY	UNIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UMIT	TOTAL	QTY × FAIL. RATE
THORSE OF		1800	Lego.	HANUFACTURING	ASSEHBLY	RATE	RATE	i wan i wai
MC 8504P	9	5.75	34.50		48	.715	4.290	24.668
DH 75529	7	1.29	5.16		32	.715	2.860	3.689
NC 556	2	.85	1.70		10	.715	1.430	1.216
TESTR MPH	9	91	.64		36	.316	1.896	. 265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	7	10.00	10.00		15	1.500	1.500	15.000
CAP Disc	10	:-	1.30		50	. 291	2.910	. 378
PC Board	2	10.00	20.00	1776	100	•		•
Misc. Hdw.	Lot	.50	.50		90			
TOTALS			158.97	1776	2054 x 2 (4108)		87.505	95.802 (4.93)

SHEET 7 OF 8

Sveren beseline Date transponder SUB-Addmis Chasis & Biologura

TOWN MAN OF								
CATROORY	5		TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & PAIL. RATE
		3		MANUPACTURING	YSSEMBLY	TATUME TATE	FATURE	x UNIT COST
PRONT PANEL	1			3,6	22			
CHARGIS	1			104	¥			
TOP COVER	1	15,00	15.00	7	22			
HOUNT	1			104	20			
BOTTON COVER	1			\$	20			
PAMEL PC BOARD	1	5.00	5.00	979	186		•	
CAVITY	2	30.00	60.00		450	900		
PARSBLECTOR	2	7.50	15.00		100	200.000	200.000	12000,000
L.P. PILTER	2	3.00	6.00		Ş	776		76777
POTENTIONETER	1	82.	82.		15	799	33.53	72.064
PUSH ST. SWITCH	1	.50	. \$0		25	16.596	70 01	2577
NOTARY SWITCH	1	1.68	1.66		100	4.415		2.013
CANIP	7	.62	4.34		100	25.856	100 003	7877
24 PIN CONNECTOR	7	.95	1.90		50	1 136		27777
MISC. HOME.	101	2.00	2.00		100		867.7	7.101
SH'T NETAL	101	3.00	3,00		200			
NF COMMECTOR	7	1.23	2.46		30			
FLEX CABLING	101	5.00	8.00		500			
CODE BUILDE	4	1.00	4.00		100	2 304		
PC COMMECTOR	9	1.26	7 56		06	777	700212	ole a
torals			133.79	1349	2136		642.551	12, 229, 649
							_	

CHEFT B OF D

-ASSEMBLY ASSY. 6 Test

2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	5	ALO OLA	TIME	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × PAIL. PATE
	CATEGORY		T900	C067	HANUFACTURING	ASSEMBLY	PATE	RATE	I COOL
1	P Jesp	2				100			
1 1 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	powed/poi					75			
1	wr Supply	1				150			
	nc/Dec 11	1				25			
2 7 7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	nc/Dec #2	1				25			
2 2 1 1 PEC 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	avity	2				200			
	reselector	2				100			
	P Filter	2				100			
	Tont Panel	-				25			
		lot				25			
						200			
	wrn-In	,				600			
	est	•				1000			
					,				
TOTALS	OTALS					2925			

APPENDIX A-4

BASIC DABS WITH 21.5 dBW AT ANTENNA (Discrete Version)

SHEET 1 OF 8

SYSTEM DABS Transponder

SUB-ASEMBLY IF ANDLIKEE

ITEM NAME OR) Jun	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	QTV x FAIL. RATE
		rep.		HANUFACTURING	ASSEMBLY	PATE	FAILURE	× UNIT COST
7416	1	.88	88.		8	. 786	. 786	.692
74121	1	16.	16.		69	. 786	. 786	.244
IN277	1	, 36	. 36		S	.715	.715	.257
114151	•	.30	8.		15	. 150	.450	stt.
114743	1	.20	.20		5	. 786	. 786	.157
2N5086	3	-11.	.17		10	2.124	6.372	. 361
MP56515	1	.43	.43		9	.316	.316	.136
MPSH10	1	.33	.33		9	916.	, 316	.104
SPS6797	8	. 78	6.24		48	.715	5.720	4.462
5082-2835	4	38	98.		5	.715	۶۲.	2.72
TSTR. SI	1	.41	.41		9	. 316	. 316	130
D100E. S1	1	.32	. 32		5	. 155	155	050.
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	. 160	. 320	.115
CAP. DISC.	45	.13	5.85		225	. 291	13.095	1.702
Cae. 1	3	.41	1.23		15	. 550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.632	520.
ZHOKO	9	. 36	2.16		36	2.120	12,720	4.579
COIL	5	.12	99.		30	.069	.345	150.
COIL RF	2	. 28	.56		12	.475	. 950	. 266
CRYSTAL	1	8.00	8.00		15	1.500	1,500	12.000
FILTER	1	.28	, 28		9	5.127	5.127	9.7
TVFA1.S								

SHECT 2 OF 8

SYSTEM DABS Transponder

SIR-ASSPER IF ARELITIES (CONT. d)

ITEM MANE OR CATEGORY	PT	UNIT	TOTAL.	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY X FAIL. RATE
		1 933	(Pa	HANUFACTURING	ASSEMBLY	FAILURE	FALLURE	x UNIT COST
TRANSP	و	. 38	2.28		40	2.309	11.854	276.5
PC Board	-	4.00	4.00	873	25			J. 603
MISC. Hdv.	101	05,	.50		50			
SHT. MTC.	Į	1.50	1,50	163	3			
THAIS			44.25	985	907 x 1.5 (1481)		70.342	35.445

SHEET 3 OF 8

SYSTEM DABS Transponder

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR	ž,	1180	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	TOTAL	QTY × FAIL. RATE
CATEANKI		COST	CAST	HARUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7404		.26	. 26		89	212	.715	.186
7408	1	.26	.26		60	.120	.120	160.
7478	1	.31	18.		8	.715	. 715	.222
74121	1	Tr.	17		G	2115	715	222
74132	1	.64	-64		.	.120	.120	720.
67121	7	1.24	1.24		9	.715	.715	198'
2N3646	1	89.	.68		9	. 316	.316	215.
MPSA56	2	-11	34			316	632	701
CAP DISC.	15	113	1.95		75	.291	4.365	.567
CAP VAR.	-	.23	.23		15	8.599	8,599	1.978
RESISTOR PC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOO	-	5.00	5.00		50	.715	3115	3.575
POTENTIONETER	~	.42	.42		15	.664	.664	.279
PC Board	-	2.00	2.00	818	25			•
MISC. HDW	EQ.	.50	.50		90	•		•
TITALS			14.35	918	329,8,1.5		16.462	12.33,

-| SHEET

SYSTEM DASS TRANSPONDER

ITEM NAME OR CATEODRY	710	LINIT	TOTAL	TANDE HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTV = PATL. HATI
		3	3	MANUFACTURENG	ASSEMBLY	TATUM. NATE	rature Are	# UNIT COUT
MJE200	~	.57	1.14		16	1.970	9.	
MJE1100	1	1.33	1		·			7. 240
MJE2801	-	1.33	1.3			0781	7.570	268
2M4733A	-	2	8			1.970	1.970	2.630
					•	. 766	. 786	.157
1M4735A	-	8.	02.		\$. 786	. 786	531
184742A	-	2	20		ຜ	.766	786	1 3
IN\$2298	-	\$11.	\$1.		,	304		/2
2M2222A	7	.40	0			86,	98/	9 77
96H 30	2	.80	1.60		9	277	arr.	126
TASTR, S.I	1	. 15	.15		,	21.	ore:	.240
Diode, SI	3	35	07.		9.	377	916.	.00.
RESTRETOR PC.	=] ; 					010	. 109
Bratema ur	.	37	7	•	- 25	110	141	700
THE STATE OF THE S		.,	.74		10	.042	780	043
Wit.	-	- 12	.48		24	990	37.6	
CN AL.	•	•	3.36		24			1767
CAP DC	10	=	1.30				7.310	2.113
TRANSFORMER		;			8	.291	2.910	. 370
POTENTIONETE?			7.44		40	6.294	8.988	21.955
PC BOARD			1.68		30	.644	1.320	1,116
200	-	8/2	2.00	910	3.2	:		
Tree. Her.	5	ŝ	.50		S			
ant mil.	5	S.	. 50	167	\$0	:		
TOTALS			20.73	985	442 x 1.5 (663)		28.269	34.249 (5.45)
				•	•			

SYSTEM Beseline DASS Transponder SUB-ASSESTY Decoder/Encoder

ETTER MAME OR CATEGORY	91	# # # # # # # # # # # # # # # # # # #	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	101AL	OTY & PAIL. MATE
		3	3	HANUFACTURING	ASSEMBLY	TAILURE PATE	TAILUNE PATE	x UNIT COST
7400	2	.24	97		16	120	3.40	
7403	~	.24	и,		24	3		•60.
7404	10	,26	2.60		9		nar.	980
7407	-	3	:		75	2117	7.150	1.052
	-	1	77			-235	-213	329
7408	2	32	5.20		160	120	2.400	624
7432	-	28	1.62		36	021.	.840	216
2470	٠	111	2,79		117	214	* 436	
7485	۰	141	7.56		72	3,6	2001	2447
7496	٠	. 55	3.30		10	120		207
7491A	-	3.	2.76		24	715	2 144	200
74130	-	.65	.69		•	71.6		
74150	-	.97	.97		10	- 517	3,7	505
74153	~	.72	1.44		16	715	9.5	
74154	4	1.07	1.07		77	21.	1	266
74157	•	n.	9.76		00	.718	220	- 11.
74161	٩	151	9875		90	.715	6.435	1.478
74164	-	6.	6.51		56	.718	5.005	4.655
74164	25	6.	23.25		250	sır.	17.075	16.264
74174	7	-79	957		30	.715	1.430	1.130
24196	+	1.43	5.72		46	.738	2.860	4.00
741021	7	H	1.69		34	000	.420	101
74821	1	128	1.29		12	214	216	
TOTAL								
		•		_				

SYSTEM Baseline DABS Transponder

SUB-ASSIDENT DECODER/Encoder

FTEN NAME OR	QT.	T190	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OT * PAIL. MATE
		1890	Tens	MANUFACTURING	ASSEMBLY	FATCURE	FAILURE	x UNIT COST
NC 8504P	9	5,75	34.50		48	317.	4.290	24.658
DH 75529	4	1.29	5.16		32	.715	2.860	3.689
NC 556	2	•85	1.70		10	.715	1.430	1.216
TRSTR NPN	9	म	-84		36	.316	1.896	. 265
Registor	88	:03	2.64		440	.013	1.144	.034
Crystal	1	10,00	10.00		15	1.500	1.500	15.000
CAP Disc	10	.13	1.30		50	. 291	2.910	.378
PC Board	7	10.00	20.00	1776	100		,	
Misc. Hdv.	Lot	.50	.50		50			
TURIS			158.97	1776	2054 x 2 (4108)		87.505	95,802 (4.93)

SHELT 7 OF 0

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR	DTV	TINO	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & FAIL. RATE
		3		NAPIUFACTIURING	ASSEMBLY	FAILURE RATE	FALURE	X UNIT COST
FRONT PANEL	1			74	22			
CHASSIS	1			184	44			•
TOP COVER	1	15.00	15.00	41	22			:
MOUNT	1			184	20			
BOTTOM COVER	1			48	20			
PANEL PC BOARD	1	5.00	5.00	818	200		•	•
CAVITY	1	30.00	30.00		225	300 000	- 000	
PRESELECTOR	1	7.50	7.50		50	91.1	000,000	6000.000
L.P. FILTER	-	3.00	3.00		25	11.044	1.180	0.850
POTENTIONETER	1	. 35	35.		15	777	11.844	15.532
PUSII BT. SWITCH	1	.50	.50		25	18 596	100.00	. 232
ROTARY SWITCH	1	1.68	1.68		100	20 0 V	10.0%	9.298
LAMP	2	.62	4.34		100	200 30	C14.7	7.417
24 PIN CONNECTOR	2	.95	1.90		\$0	90.63	180.992	112.215
MISC. HDW.	LOT	2.00	2.00		100	1:170	7.756	2.143
SH'T METAL	LOT	3.00	3.00		900		-	
RF CONNECTOR	1	1.23	1.23		15			-
FLEX CABLING	LOT	5.00	5.00		500			
CODE SWITCH	4	1.00	4.00		100	2. 195	0 580	000
PC Connectors	٦	1.26	6.30		75		1	5.380
TUTALS			90.80	1349	1808		429.527	6185.267 (64.80)

SHEET 8 OF 8

SYSTEM SUR-ASSEMBLY ASSY, 6 Test

TEN NAME OF	740	E	MANAGE	STAME COOL BOD BODY	1000 liners	111111	10131	OTV v PAIT CATTE
CATEGORY	;	J.SOO	COST	PIANUFACTURING	ASSEMBLY	FATLURE	FAILURE	x UNIT (UST
IF Ano	1				50			
Mod/Demod	1				50			
Pur Supply	1				150			
Enc/Dec 81	1	•			25			
Enc/Dec #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	4				25			
Covers	lot				25			
Alignment					500			
Burn-In	•				500			
Test	,				1000			
TUTALS					2550			

APPENDIX A-5

DABS WITH COMM A AND B (Discrete Version)

SHEET 1 OF 8

SYSTEM DABS Transponder

sun-assiment of Amolifier

CATECORY	710	TIN	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY × FAIL. RATE
		ıem	93	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE RATE	x unit east
2416	1	88	.88		Œ	786	786	607
74121	1	.31	.31		80	.786	786	446
LINZTZ	1	.36	. 36		\$.715	.715	750
114151	3	. 30	.90		15	. 150	.450	.135
IN4743	1	.20	. 20		5	. 786	. 786	157
2N5086	3	11.	.17		18	2.124	6.372	.361
MPS6515	-	197	43		9	. 316	.316	.136
MPSHIO	7	.33	.33		9	. 316	.316	104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		5	311.	57.	2.72
15TR. 51	1	Ŧ.	.41		9	. 316	.316	130
DIODE, SI	1	20	. 32		5	,155	.155	050
CAP. STO.	4	.91	3.12		18	629	2.516	2 340
CAP. CER.	2	. 36	27.		10	.160	. 320	.115
CAP. DISC.	\$	113	5.85		225	. 291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	919.
RESISTOR A/C	64	:03	1.92		320	. 013	.632	.025
CHOKE	9	36	2.16		36	2.120	12.720	4.579
7100	2	217	99.		30	690.	.345	.041
COIL NE	2	.28	.56		12	.475	.950	. 266
CRYSTAI.	1	9.00	8.00		15	1.500	1,500	12.000
PILTER	1	.28	. 28		9	5.127	5.127	1.4%
TOTALS								

BIIECT 2 OF

SYSTEM DABS Transponder

SUN-ASSEMBLY IF ANDLILLAR (CORE'd)

TITTH MANE OR	M.	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OTY A PAIL. RATE
CATEMORY		1900	208T	HANUFACTURING	ASSEMBLY	PATE	RATE	TO X
TRANSF	9	. 30	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	618	25	•	•	•
MISC. HOW.	101	650	. 50		50	8		•
BHT. HTC.	101	1.50	1.50	767	20	•		•
TOTAL			44.25	\$86	987 x 1.5		70.342	18:199 18:199

1:

SYSTEM DASS Transponder

BUR-ARSEMBLY DESK DENOD. / PPM MOD.

	_					ATT A CALL MATE
1 .26 1 .36 1 .36 1 .31 1 .34 1 .34 1 .34 1 .34 1 .34 1 .34 1 .34 1 .33	COST	PLANUFACTURING	ASSEMBLY	TATE TATE	FALUNE	x mart creat
1 .26 1 .31 1 .31 1 .31 1 .31 1 .42 169 169 169 169 169 169 169 169 169 169 169 169 169 169 169 217 203 213 2			•	.715	215	7106
1 1, 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	.26		0	. 120	.120	.031
1 1.00 1			8	.715	.715	.222
1 1.06 2 1.1 2 1.0 2 1.1 1 1.0 1 1.0	_		•	2113	215	122
1 1.24 2 1.7 15 1.13 1 2.00 1 2.00 1 2.00 1 2.00 2 1 3.0	_		0	120	.120	27.0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-		9	.715	3115	.867
2 17 1 1 13 13 1 1 142 1 1 1 2.00 2 1 2.00 2 1 2.00 2	3.		9	. 316	. 316	215.
1	117		12	316	612	107
1 3.00 3 1 3.00 3 1 3.00 2 100 2	1,13		75	.291	4.365	. 567
1 2.00 1 3.00 1 3.00 1 3.00	.23		15	9.599	6.599	1.978
1 2.00	.01		35	610,	160'	1001
1 2.00 2 2 1 2.00 2 1 2.00 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.00 2 2 1 2.	5.00		50	ns	2115	3.575
1 2.00 2. 107 .50	.42		15	. 664	.664	.279
05. 201	2.00	616	25		-	
	. \$0		50	•	ŧ	1
		į				
TOTAL	14.35	810	3234 1.5		18.402	12.33)

ğ SHEET 4

SYSTEM DABS THANSPONDER
SIR-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	OTY	TIMO	TYTAL	LAPOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	TOTAL	QTY × FAIL. RATE
		3	3	HANUFACTURING	ASSEMBLY	FATLURE PATE	FAILURE RATE	* UNIT CAST
MJE200	2	.57	1.14		16	1.970	3.940	2 246
NJE1100		1.33	1,33		•	0,0		
NJE2801	1	1.33	1.33		0 00	920	078.0	2.620
IN4733A	1	. 20	.20		5	797	1.970	2.620
IM4735A	1	2.	. 20				8	, E.
IN4742A	7	. 20	.20		5	700	3	157
IN5229B	-	.15	.15			200	8	751
2N2222A	1	.40	.40		9	316	780	. 116
SEM 30	2	.80	1.60		10	.155	310	977
TRSTR, SI	-	.15	.15		9	.316	316	242
DIOUE, SI	7	.35	۰۲۵		10	.15\$.310	109
RESISTOR FC.	1	.03	.33		5.5	613		
RESISTOR MF	7	.37	.74		10		1 22	700
COIL	Ą	.12	.48		24	060	100	242
CAP AL.	9	. 84	5.04		36	629	1 23.6	160.
CAP DC	10	. 13	1.30		50	201	200	3.170
TRANSPORMER	1	2.44	2.44		40		2:240	. 3/8
POTENTIONETER	2	.84	1.68		0.	9.770	8.998	21.955
PC BOARD	1	2.00	2.00	818	36		1.328	1.116
MISC. JIDW.	101	. 50	.50		20	-		
SIT HTL.	1.OT	. 50	.50	167	3		:	
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SHEET 5 OF 8

SYSTEM DARS Transponder

SUB-ASSISTELY Decoder/Encoder

ITEM NAME OR	ST.	TIMD	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	FINI	10231	
CATERORY		1500	1900	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7400	_	.24	.72				315	
7402	,	;			5	.120	. 360	980.
	1	**	8.		32	.120	.480	.115
7404	91	.26	2.60		80	.715	7.150	1.659
7407	-	.32	. 32		•	.715	2115	220
7408	20	.26	5.20		160	120	2,400	
7432	,	.26	1.82		56	.120	940	910
7478	6	.31	2.79		117	.715	6.435	1 995
7485	6	.84	7.56		72	.715	6 415	304.3
7486	•	.55	3.30		48	.120	720	2000
7491A	7	.92	2.76		24	315.	2.145	1 673
74126	1	**	.44		8	.715	715	315
74138	-	59:	.65		8	.715	.715	465
74150	~	.97	.97		10	.715	715	789
74153	2	.72	1.44		16	2115		660.
74154	1	1.07	1.07		12	715	715	050.1
74157	6	7.7	6.48		8	311		69/
74161	6	.54	4.86		90		6.415	4.633
74164	7	.93	6.51		200	- 113	6.435	3.475
74166	25	6	23.25		96		5.005	4.655
74174	,				250	-215	17.875	16.264
	•		1.38		20	.715	1.430	1.130
R 19/	+	1.43	5,72		49	.715	2,960	060.₽
141841	-	-24	1.68		56	.060	. 420	tot.
TOTALS								
•		_						

SHEET 6 OF 8

Decoder/Encoder

SUB ASSEMBLY

OTY x FAIL. RATE x UNIT COST . 922 24.668 5.291 4.612 1.216 265 378 0.34 15,000 102.903 TOTAL Failure Rate .715 90.605 4.290 .715 1.430 3.575 1.8% 1.144 1 500 2.910 UNIT FAILURE RATE .715 .115 .715 .715 .715 .316 60 1.500 .291 LABOR HOURS PER 1000 UNITS ASSEMBLY 2) 32 × 2 (4264) 100 440 8 8 8 \$ 2 2 4 S 50 MANUFACTURING 1776 1776 TOTAL 1.29 34.50 7.40 6.45 1.70 7.64 10.00 2 3 20.00 1.50 18 170.30 1.29 7.40 1.29 UNIT COST 5.75 4 = 8 10.00 1.50 7 10.00 ž 3 9 2 ~ ~ ITEM NAME OR CATEGORY TRSTR MPN MISC. HOW. HH74C910 Besistor CAP DISC PC Board MC8504P DH75529 Crystal 745271 RATAIS MC556

SHEET 7 OF 8

STEM Baseline DABS Transponder

B-ASSDELY Chasis & Enclosure

ITEM MANE OR CATECONY	22	UNIT	TOTAL	LABOR HOURS PER 1600 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL, RATE
				HABUFACTURING	ASSEMBLY	FAILURE RATE	FALLURE	x UNIT COST
FRONT PANEL	-			74	22			
CHASSIS	1			184	44			
TOP COVER		15,00	15.00	41	22			•
MOUNT	1			164	20			
BOTTON COVER	-			48	20	1		
PANEL PC BOARD	-	5.00	5.00	818	100	1		-
CAVITY	1	30.00	30.00		225	200.000	000 000	-
PRESELECTOR	1	7.50	7.50		50	1.18	000.000	6000.000
L.P. FILTER	1	3.00	3.00		25	11.844	11 044	9.830
POTENT I OMETER	1	. 35	.35		15	664	11.044	35.512
PUSH BT. SWITCH	1	.50	.50		25	18.596	10 506	232
ROTARY SWITCH	-	1.68	1.68		100	4.415	4 416	9.238
LAMP	,	.62	4.34		100	75 856	200 001	/. 41/
24 PIN CONNECTOR	R 2	26.	1.90		50	05.1	190.732	112.215
HISC. HDW.	101	2.00	2.00		100	071.1	7.730	2.143
SH'T METAL	101	3.00	3.00		200			
RF CONNECTOR	1	1.23	1.23		15			-
FLEX CABLING	LOT	5.00	5.00		500			•
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	003.0
PC Connectors	S.	1.26	6.30		75			2.300
Torals			90.80	1349	1808		429.527	6185.267

SHEET 8 OF 8

SUB-ASSIMBLY ASSY. 6 Test

ITEM NAME OR	QTV	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY x FAIL. RATE
		J GCT	1800	HANUFACTURING	ASSEMBLY	FATE RATE	RATE	
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Enc/Dec #1	1				25			
Enc/Dec 12	1				25			
Cavity	1				100			
Preselector	-				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	lot				25			
Alignment	•				500			
Burn-In	,				500			
Test	•				1000			
TOTALS					2550			

APPENDIX A-6

DABS WITH COMM A AND B AND ATARS
(Discrete Version)

SYSTEM DASS Transponder

sus-assembly it and	and lifter					,		
ITTH HAME OR	OTV	FIS	TOTAL	LAMOR HOURS PER 1600 UNITS	1000 UNITS	TIMO .	TOTAL	QTY # PAIL. RATE
CALINORI			CUBT	HANUFACTURING	ASSEMBLY	RATE	RATE	H CHET COST
7416	-	96	90'		•	, 786	. 786	. 692
74121	1	16.	π,		8	. 786	.786	. 244
IM277	1	,36	. 36		5	. 715	.715	.257
184151	3	. 30	8.		15	. 150	. 450	.135
114743	1	.20	92		5	. 786	. 786	151.
2N5006	-	77	74.		10	2.124	6.372	. 361
MP86515	1	187	14.		9	. 316	. 316	.136
MP\$H10	1	.33	.33		9	. 316	. 316	, 104
1619848	0	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		S	\$17,	, 75	2.72
TETR. SI	4	. 11	19.		ø	, 316	916.	081.
DICOR. ST	4	25.	77		5	155	.155	050
CAP. STO.	4	18.	7.72		91	.629	2.516	2,340
CAP. CER.	7	. 36	.72		10	. 160	. 320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAE, T	3	.41	1,23		15	. 550	1.650	.676
REGISTOR A/C	3	.03	1.92		320	.013	.632	.025
CHOKE	9	96.	2,16		36	2.120	12.720	4.579
7100	\$.13	9.		30	690.	. 345	.041
COIL NE	2	. 20	.56		12	.475	.950	. 266
CRYSTAL	1	6.00	8		15	1.500	1,50	12.000
FILTER	4	128	. 28		c	5.127	5.127	1.436
TOTALS								
	•		_					

SHEET 2 OF 10

SYSTEM DABS Transponder

SUB-ASSEMBLY IF ABOLITIES (Cont.d)

ITEM NAME OR	gr,	CANIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE
		T SST	CIBIL	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	X ONLY CAST
TRANSF	9	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.80	4.00	918	25	•		
MISC. Hdw.	101	05,	.50		50	•	-	-
SHT. MTC.	101	1.50	1,50	167	50		•	•
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	(2.27)

ITEM NAME OR	QTY	TINU	TOTAL	LANOR HOURS PER 1000 UNITS	JOOO UNITS	UNIT	TOTAL	OTY × FAIL. RATE
		1800)	1600	HANUFACTURING	ASSEMBLY	FATLURE	FAILURE RATE	x UNIT COST
7404	1	. 26	.26		6	71.5	716	, ,
7408	-	. 26	. 26		8	.120	.120	031
7478	1	,31	11.		8	3115	715	222
74121	4	11	187		Œ	715	716	
74132	1	.64	.64		80	120	130	933
67121	1	1.24	1.24		9	317.	.715	1887
2N3646	7	.68	.68		9	.316	.316	.215
MPSA56	2	.17	.34			.116	619	101
CAP DISC.	15	113	1.95		75	162.	4.365	.567
CAP VAR.	-	23	.23		15	8.599	6.599	1.978
RESISTOR PC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOOP		5.00	5.00		50	.715	.715	3.575
POTENT I OMETER	-	.42	.42		15	.664	.664	972.
PC Board	-	2.00	2.00	918	25			1
MISC. HOW	נסד	.50	. 50		50			-
TVTALS			14.35	918	329.4, 1.5		18.482	82.383)

SHELT 4 OF 10

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR	QTY	UNIT	TOTAL.	LABUR HOURS PER 1000 UNITS	1000 UNITS	TIMO	107AL	OTV × FAIL, RATE
CALEGORIA		COST	COST	MANUFACTURING	ASSEMBLY	FATLURE	FAILURE RATE	* UNIT COST
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	-	1.33	1.33		80	1.970	1.970	2 620
MJE2801	1	1.33	1.33		83	1.970	1.970	2.620
IN4733A	7	. 20	. 20		5	. 786	. 786	.157
IN4735A	-	. 20	. 20		5	786	.786	.157
IN4742A	7	. 20	. 20		5	. 786	. 786	.157
IN5229B	7	.15	. 15		5	. 786	786	.118
2N2222A	-	.40	.40		9	. 316	. 316	. 126
SEM 30	7	· 80	1.60		10	.155	.310	.248
TRSTR, SI		. 15	.15		9	.316	316.	.047
DIODE, SI	2	. 35	07.		10	.155	310	.109
RESISTOR FC.	11	.03	133		55	.013	141	\$ 00
RESISTOR MF	~	.37	.74		10	.042	. 084	.047
ω1 Γ	4	.12	.48		24	690.	276	160.
CAP AL.	9	.84	5.04		36	.629	3.774	3.170
CAP DC	10	113	1.30		50	. 291	2.910	. 378
TRANSFORMER	7	2.44	2.44		40	9, 998	8,998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1, 328	1.116
PC BOARD	-	2.00	2.00	818	25	1	-:	
MISC. HDW.	LOT	. 50	.50		50		i	
SHT MIL.	101	. 50	.50	167	20		1	
TOTALS			22.41	785	425 x 1.5 (678)		29.57	35.306 (5.38)

ITEM NAME OR	QTY	LNIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	101AL	OTY × FAIL. RATE
CAIRCON		COST	COS.F	HANUFACTURING	ASSEGUEY	FATLURE	FATLURE	TSS TIMO X
7400	3	.24	27.		24	.120	. 360	980 .
7402	4	.24	96.		32	.120	.480	511.
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	. 32	. 32		8	311.	.715	. 229
7408	20	.26	5.20		160	.120	2.400	,624
7432	,	, 26	1.82		56	.120	.840	.218
7478	6	.31	2.79		117	.715	6.435	1.995
7485	6	.84	7.56		12	.715	6,435	5.405
7486	9	.55	3.30		48	.120	.720	. 396
7491A	7	.92	2.76		24	.715	2.145	1.973
74126	1	.44	. 44		8	.715	.715	.115
741.38	7	.65	.65		80	. 715	.715	. 465
74150	7	.97	.97		10	.715	.715	€94
74153	2	. 72	1.44		16	.715	1.430	1.030
74154	-	1.07	1.07		12	.715	.715	. 765
74157	6	.72	6.48		90	.115	6.435	4.633
74161	6	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16,264
74174	2	.49	1.58		20	.115	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
741.521		.24	1.68		56	.060	.420	.101
TOTALS								

SHEET 6 OF 10

SUB-ASSPARIA Decoder/Encoder

TEM NAME OR CATEGORY	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	10TAL	OTY * FAIL. RATE
				HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	* UNIT CUST
145271	7	1.29	1.29		100	.715	.715	927
MC8504P	9	5.75	34.50		48	.715	4.290	24 660
HH74C910	1	7.40	7.40		8	.715	.715	5.291
DM75829	2	1.29	6.45		40	.715	3.575	4.612
NC556	2	-885	1.70		10	.715	1.430	1.216
TRSTR NPN	9	41	184		36	. 316	1.896	265
Resistor	88	.0	2.64		440	1013	77.1	710
Crystal	4	10.00	10.00		15	1 600		.034
CAP DISC	20	.13	1.30		50	.291	2.910	178
PC Board	2	10.00	20.00	1776	100	,	,	
Misc. Hdv.	lot	1.50	1.50		50			
		}						
TOTALS			170.30	1776	2132 K 2 (4264)		90.605	102.903

SYSTEM DABS TRANSPONDER SUB-ASSEMBLY ATARS

ITEM NAME OR	ě	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIM	TOTAL	OTY * FAIL. BATE
CATEGORY		00 ST	CO61	MANUFACTURING	ASSEMBLY	KATE	FALLURE	× Ordit COST
7400	5	.24	1.20		0	.120	009.	.144
7404	•	.24	%.		32	.715	2.860	989°
7408	10	97.	2.60		90	.120	1.200	.312
7416	2	75.	.54		16	.120	.240	065
7417	7	12.	1.89		56	,120	.640	.227
7432	7	92.	1.82		56	.120	.840	.218
7447A	80	.86	6.88		64	311.	5.720	4.920
7478	8	.31	2.48		64	-1115	5.720	1,773
74138	1	.65	.65		8	.715	. 715	.465
74157	1	77	.72		9	.715	.715	515
74164	7	.93	6.51		95	.715	5,005	559.1
74166	8	.93	7.44		64	.715	4.720	5.320
741.521	2	.24	6		16	090	.120	670
556	1	8	¥		89	715	715	989
SW74186	7	11.43	22.86		16	.715	1.430	16, 345
CAP DISC	10	.13	1.30		80	.291	2.910	. 378
RESISTOR	S	.03	1.50		400	.013	.650	.020
LED DLY 6661	12	2.07	24.84		9	.715	8.580	17.761
LED HLAP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	62.	4.64		80	.715	11.44	3.318
LED CQV 38-3	8	.30	2.40		40	.715	4.720	1.716
TOTALS								

SHEET 8 OF 10

SYSTEM DASS TRANSPONDER

SUD-AGSPRELY ATARS

ITEN NAME OR CATEGORY	OT.	#1M1	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITE	UNIT	TOTAL	QTY & PAIL. RATE
		3	3	HANUFACTURING	ASSEMBLY	ratur: Rate	rature Rate	* UNIT COST
P.C. BOARD	2	4.00	9,00	1636	3			
MISC. HDW.	5	.50	. 50		\$0			
TOTALS			104.67	1636	1354 x 1.5 (2031)		63.170	62: 956

SYSTEM DABS Transponder

70

ğ

Φ

SHEET

SUB-ASSEMBLY Chassis & Enclosure

OTY × FAIL. RATE × UNIT COST 8.850 35,532 .232 9.298 6000.000 64,123 2,143 9.580 6137.175 (78.47) TOTAL FATLURE RATE 1.180 11.844 18.596 2.256 200.000 9.580 103,424 351.959 UNIT FAILURE PATE 11.844 18.596 4.415 200.000 25.856 1.128 2.395 1.18 ı LABOR HOURS PER 1000 UNITS ASSEMBLY 225 25 05 2 2 20 2 2 22 20 20 200 9 8 13 100 105 8 1698 HANUFACTURING 7 2 8 4 184 531 15.00 30.00 7.50 3.00 1.68 2.48 .35 1.90 TOTAL 2.00 3.00 1.23 5.00 **4**.00 8.82 86.46 15.00 7.50 1.68 UNIT COST 30.00 3.00 .35 3.00 1.23 8 2.00 5.00 1.00 .62 1.26 5 5 ğ ğ ~ 4 24 PIN CONNECTOR ITEN NAME OR CATEGORY PUSH BT. SWITCH POTENTI CHETER ROTARY SWITCH BOTTOM COVER RP COMMECTOR PLEX CABLING PC CONNECTOR PRONT PANEL PRESELECTOR L.P. PILTER SH'T METAL THUMBANEEL MISC. HDW. TOP COVER TOTALS CHASSIS CAVITY HOUNT LAMP

SYSTEM DABS with COMM ALB and ATARS

SHEET 10 OF 10

8UB-ASSEMBLY ASSY. 6 Test

CATEGORY	ž Ž	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	JOOO UNITS	TIMO	TOTAL	OTY X FAIL, MATE
				HANUFACTURING	KTBKSSV	FAILURE	FAILURE	x UNIT COST
IF Amp	7				. 50			
Mod/Demod	~				. 50			
Pvr Supply	7				150			
Logic Bd 61	1				25			
logic Bd. #2	7				25			
ATARS #1	4				25			
ATARS 12	4				25			
Cavity	1				100			
Preselector	7				50			
P rilter	4				20			
Front Panel	7				200			
COVETS	lot				25			
Alignment	•				200			
Purn-In	-				500			
Test	•				1500			
TOTALS					3275			

APPENDIX A-7

DABS WITH COMM A AND B, ATARS AND BCAS INTERFACE

(Discrete Version)

SHEET 1 OF 10

SYSTEM DABS Transponder SUB-ASSEMBLY APPLICATE

OTY * FAIL, RATE * UNIT COST .692 .257 .135 .136 .244 .157 104 2.72 130 . 361 4.462 .050 2.340 .115 1.702 929. .025 4.579 .266 12.000 . 140. 1436 TOTAL FAILURE RATE .786 .715 .450 . 786 .786 6.372 .316 316 5.720 316 .155 . 320 2.516 13.095 . 832 12.720 . 345 .950 1.650 1,500 5.122 52 UNIT FAILURE RATE 786 .715 . 786 .150 . 786 2.124 .316 316 .715 .715 316 .629 ,155 100 .291 . 550 .01 2.120 .069 .475 1.500 5.127 LAISOR HOURS FER 1000 UNITS ASSEMBLY 15 18 # = 2 320 225 2 12 2 읽 2 NANUFACTURING TOTAL .43 8 8 8 2 .17 .3 6.24 퓌 8 3.72 1.23 1.92 2.16 8.8 ₹ .32 2. 5.85 3 8 .28 UNIT COST 20 117 8 7 36 위 .43 .33 .78 胃 41 32 2 8 .13 4 9 8 .12 . 28 8.00 .28 4 8 \$ 2 RESISTOR A/C ITEM NAME OR CATEGORY CAP. DISC. 5062-2035 DIODE. SI CAP. STO. CAP. CER. TSTR. SI SPS6797 HFS6515 CRYSTAL IM4151 CAP. T 2N5086 MPSHIO COIL RF IM4743 FILTER 74121 IN277 TOTALS CHOKE 7416 **2011**

SHEET 2 OF 10

SYSTEM DABS Transponder

SIM-ASSEMBLY IF Amplifier (Cont'd)

ITEN NAME OR	Orx	1 2	TOTAL	STITUTE OF BEAR SHOWN BONT	34.1411 0000			
CATECORY		TSW	COST	MANUENCTURING	A lung 394	FAILURE	FAILURE	K UNIT CHEF
TRANSF	9	.38	2.28		40	3 300	315	
PC Board	1	4.00	4.00	918	25	5.303	13.834	5.265
MISC. IIdw.	LOT	,50	.50		50			-
SHT, MTC.	TOT	1.50	1,50	167	05			-
							-	
					-			
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445

SHEET 3 OF 10

SYSTEM DABS Transponder

SUB-ASSEMBLY DPSK DENOD./PPH NOD.

ITEM NAME OR CATEGORY	Ωıχ	TIND	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY * PATL. PATE
		1 CONT		HANUFACTURING	ASSEMBLY	FAILURE RATE	FAILURE	x UNIT COST
7404	1	. 26	.26		6	215	31.6	
7408	-	.26	. 26			00.1	557	186
7478	1	.31	33				277	150:
74121		:			8	.715	-715	.222
13161	1	4	11		В	-215	715	222
74132	1	.64	.64		8	,120	120	720.
67121	1	1.24	1.24		9	.715	.715	.887
2N3646	1	89.	.68		9	.316	.316	.215
MPSA56	2	-11	.39		12	. 316	632	202
CAP DISC.	15	13	1.95		75	.291	4.365	267
CAP VAR.	7	.23	.23		15	8.599	8,599	1.978
RESISTOR FC	7	.03	.21		35	.013	160	100
PHASE LOCK LOO	-	5.00	5.00		50	.715	715	3 575
POTENTIOMETER	7	.42	.42		15	.664	.664	976
PC Board	1	2.00	2.00	918	25			
MISC. HDW	LOT	. 50	.50		50			
TITALS			14.35	818	329.4, 1.5		18.482	£2.83)

SHEET 4 OF 10

SYSTEM DABS TRANSPONDER

SUR-ASSIMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	ρτν	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & FAIL, RATE
		8	93	HANDEACTURING	ASSEMBLY	FATEURE.	FAILURE RATE	x UNIT COST
MJE200	2	.57	1.14		16	1.970	3.940	2.246
NJE1100	1	1.33	1.33		œ	1 970	950	
MJE2801	1	1.33	1.33		8	1.970	1 070	2 620
IN4733A	1	. 20	. 20		5	. 786	786	157
IN4735A	1	. 20	. 20		5	786	701	
IN4742A	1	. 20	. 20		2	786	787	751
IN5229B	1	.15	.15		2	786	201	761
2N2222A	1	.40	04.		و	316	316	271.
SEM 30	2	.	1.60		10	.155	. 310	.248
TRSTR, SI	-	. 15	.15		9	.316	.316	.047
DIODE, SI	2	.35	. 70		10	. 155	.310	. 109
RESISTOR FC.	11	.03	.33		55	110		
RESISTOR MF	2	.37	.74		10	042	700	000
COIL	4	.12	.48		24	.069	276	160
CAP AL.	9	.84	5.04		36	.629	3.774	02.1.1
CAP DC	10	.13	1,30		50	. 291	2.910	37.6
TRANSFORMER	-	2.44	2.44		40	8 998	8 000	310 10
POTENTIONETER	7	. 84	1.68		30	.644	1, 178	2116
PC BOARD	-	2.00	2.00	818	25	:		
MISC. HDW.	F.03	. 50	.50	1	50	1		
SIT ML.	53	.50	. 50	167	50			
TYTAIS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.18)

SHEET 5 OF 10

SYSTEM Baseline Labs with Comm A & B and BCAS Interface

SIM-ASSIMBLY Logic Boards

ITEM NAME OR CATEGORY	QTY.	UNIT TOU	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV x I'AII RATE
		200	I Gra	MANUFACTURING	ASSEMBLY	FAILURE	FATLURE RATE	x UNIT CUST
7400	57	129	3.60		40	130		
7402	4	.24	8		12	1.30	778	412
7404	12	,26	3.12		¥	716	400	
7407	1	. 32	.32				097.6	2.230
7408	24	. 26	6.24		192	215	217	.229
7432	8	.26	2.34		72	120	A BBD	749
7478	77	181	12		156	715	8 580	1950
7485	6	.84	7.56		72	.715	6.435	5 405
2486	g	. 55	3.20		48	120	720	200
7491A		-92	2.76		24	.115	2,145	1 971
74126	7	. 44	44		8	3115	715	315
741.38	7	.65	59		8	215	715	777
74150	~	.97	.97		10	.715	215	694
74153	2		1,44		16	.715	1.430	P. C.
74154	4	1.07	1.07		12	.715	315	765
74157	6	.72	6.48		90	.715	6.435	4.633
74161	6	-54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	. 715	5.005	4.655
74166	33	.93	30.69		330	.715	23.595	22.943
74174	2	-79	1.58		20	215	1.430	1.130
74198	4	143	5.72		48	.715	2,860	4.090
/4 5	7	.24	1.68		56	090	420	101
TOTALS								

SHEET 6 OF 10

SYSTEM
SUB-ASSEMBLY Logic Board

ITEM NAME OR	QTY	SELT.	TOTAL.	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & FAIL. RATE
			1600	HANUFACTURING	ASSEMBLY	RATE	CATCURE RATE	x UNIT COST
745271	1	1.29	1,29		180	.715	211.	422
HCB504P	9	5.75	34.50		48	.715	4.290	24 668
M74C910	1	7.40	7.40		8	.715	.715	5.291
DM75829	5	1.29	6.45		40	.715	3.575	4,612
NC556	2	.85	1.70		10	,715	1.430	1.216
TRSTR NPN	9	14	.84		36	. 316	1.8%	.265
Registor	88	-03	2,64		440	.013	1.144	910
Crystal	1	10.00	10.00		15	1.500	1 500	16 000
CAP DISC	10	113	1.30		50	.291	2.910	170
PC BOALD	-	2.00	15.00	1776	100			877
Hisc. Hdw.	10t	1.50	1.50		50			
		İ						
TVFALS			178.63	2454	2381 x 2 (4762)		100.86	110.152 (4.92)

SHEET 7 OF 10

SYSTEM DABS TRANSPONDER

SUN-ASSEMBLY ATARS

QTY × FAIL. RATE × UNIT COST 441 5, 320 989 317 777 .218 역 4.920 1111 .465 515 620 4.655 .686 16.345 2.503 3.318 .378 .020 17.761 1.716 TOTAL FAILURE RATE 99 2.860 1.200 949 .840 240 5.720 5.720 .715 315 5.005 4.720 1.430 .120 2.910 .650 8.580 4.720 1.43 11.44 URIT FAILURE IVTE .120 .715 120 .120 .120 120 .715 2115 .715 215 317 .715 .060 715 21. .013 .715 .715 .115 .291 .715 LABOR HOURS PER 1000 UNITS ASSEMBLY 위 2 8 의 29 26 3 99 9 0 0 64 의 a 9 욻 400 3 2 MANUFACTURING TUTAL 6,88 1.20 96 2.60 1.69 .54 1.82 2.48 -72 7.44 5 6.51 .48 22.86 1.30 1.50 24.84 3.50 4.64 2.40 a UNIT . 24 . 24 .26 7 7. 8 8 .3 6 .93 .65 -72 24 11.43 .13 2.07 1.75 .29 8 형 .03 OTY S 4 10 ~ 0 0 7 10 ~ 3 13 91 0 ITEM NAME OR CATEGORY LED HLMP-2655 LED DLY 6661 LED COV 38-3 LED CQV 36-3 CAP DISC RESISTOR SN74186 741.521 7447A 74138 TITALS 74157 74164 74166 7400 7404 7408 7416 7417 7432 1478

SHEET 8 OF 10

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY ATARS

ITEM NAME OR	gtv	TINI	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
		3	eg .	HANUFACTURING	ASSENBLY	PATE	RATE	I COO I I I I
P.C. BOARD	2	9.7	9.00	1636	50	ı	ı	1
MISC. HDW.	101	.50	.50		50	ı		•
		1						
TOTALS			104.67	1636	1354 × 1.5 (2031)		63.170	62.056

SYSTEM BASELINE DABS TRANSPONDER

SIM-ASSPELY Chassis & Enclosure

ITEM MANE OR CATEGORY	Ž,	TIMO	TUTAL	LARUR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & PAIL. RATE
		3	3	HANUFACTURING	ASSEMBLY	FAILUNE	FAILURE RATE	* UNIT COST
FRONT PANEL	4			74	22			
CHASSIS	-			184	44			•
TOP COVER	1	15.00	15.00	41	22			•
MOUNT	4			184	20			
BOTTON COVER	1			48	20	•	,	
CAVITA	1	30.00	30.00		225	200.000	200.000	6000 000
PRESELECTOR	4	7,50	2.50		50	1.18	1.180	6.650
L.P. FILTER	4	3.00	3.0%		25	11.844	11.844	25, 612
POTENTIONETER	7	.35	. 35		15	199	.664	.332
PUSH BT. SHITCH	-	.50	.50		25	18.596	18.596	9.298
ROTARY SHITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAND	4	.62	2.48		09	25.856	103.424	64.123
24 PIN COMMECTOR	R 2	-95	1.90		90	1.128	2.256	2.143
MISC. HDW.	101	2.00	2.00		100	•		
SH'T METAL	LOT	3.00	3.00		200	1		
RP COMMECTOR	1	1.23	1.23		15			
PLEX CABLING	LOT	5.00	5.00		200			
THUMBHREEL	-	1.00	4.00		100	2,395	9.580	0 580
PC COMMECTOR	8	1.26	10.08		120		,	
TOTALS			87.72	531	1713		351.959	6137.175

SHEET 10 OF 10

SYSTEM DASS TRANSPONDER

SUB-ASSEMBLY ASSY.	T. 6 Test							
ITEM MANE OR	QTV	11100	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	10TAL	OTY x PAIL. RATE
				HANUFACTURING	ASSEMBLY	FATLURE	FAILURE	x UNIT COST
17 Amp	1				20			
Mod/Demod	7				90			
Per Supply	1				150			
Logic Board 1	1				25			
Logic Board 2	1				25			
Logic Board 3	1				25			
ATAMS Board 1	-				25			
ATMS Board 2	1				25			
Cavity	1				100			
Presslector	4				90			
is riter	1				50			
Front Peecl	1				200			
Covers	Lot				25			
Alignment					200			
Durn-In	,				200			
Thet					1500			
TOTALS					3300			

APPENDIX A-8

DABS WITH COMM A, B, AND C (Discrete Version)

SHEET 1 OF 8

SYSTEM LABS Transponder

SUB-ASSEMBLY IR AMPLIFIER

ITEM NAME OR CATEGORY	QTY	TIM	TUTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	10TAL	OTY * FAIL. RATE
				HANUFACTURING	ASSEMBLY	FAILURE	FA1LURE RATE	x UNIT COST
7416	-	.88	99.		9	78%	797	
74121	-	. 11	۲.		6	796	200	269.
LN277	ب ہ	. 36	يو		4		98/	. 244
124151						67/:	.715	.257
1018417		ŝ.	38,		15	.150	.450	.135
£N4743	1	.20	. 20		5	.786	.786	.157
2N5086	7	777	-17		18	2.124	6.372	. 361
MPS6515	1	4	43		9	.316	. 316	.136
MPSH10	-	.33	.33		9	316	.316	701
SPS6797	8	. 78	6.24		48	.715	5.720	4.462
5082-2835	4	gr.	38		\$.715	75	3.73
TSTR. SI	1	14.	19:		9	.316	316	0.1
DIODE, SI	4	77	.32		5	.155	.155	050
CAP. STO.	4	193	3.72		18	629	2 516	2000
CAP. CER.	2	. 36	υ.		10	. 160	320	115
CAP. DISC.	45	113	5.85		225	.291	13.095	1.702
CAP. T		.41	1.23		15	. 550	1,650	.676
RESISTOR A/C	20	.03	1.92		320	.013	.832	.025
CHOKE	9	.36	2.16		36	2.120	12.720	4.579
COIL	S	21.	99.		30	.06)	.345	.041
COIL RF	~	.28	95.		12	.475	.950	. 266
CRYSTAL	7	8.00	B. 00		15	1.500	1.500	12.000
FILTER	~	.28	. 28		ę.	5.127	5.127	1 436
TUTALS								
		•			-	_		

SYSTEM DASS Transponder

SIR-ASSIMOLY IF MOLITIEE (Ont'd)

9

SHECT 2

QTY x FAIL. RATE x UNIT COST 5.265 35.445 TOTAL FALLURE RATE 13.854 70.342 URIT FAILURE RATE 2.309 LABOR HOURS PER 1000 UNITS ASSEMBLY 967 x 1.5 (1491) \$ 22 S S HANUFACTURING 818 291 962 TOTAL 2.28 8 8 150 44.25 S UNIT 86. €.00 1.50 2 101 4 ETEN NAME OR CATEGORY MISC. BOW. SHT. MC. PC Board TRANSF TOTALS

SHEET 3 OF 8

SYSTEM DAMS Transponder

SUR-ASSEMBLY DPSK DENOD./PPH MOD.

TEN NAME OR	QTY	TIND	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	TOTAL	QTV × FAIL. RATE
		8	Ign	HANUFACTURING	ASSEMBLY	RATE	FATLURE	x UMIT COST
7404	1	. 26	. 26		90	.115	715	186
7408	1	. 26	. 26		8	.120	.120	160.
3438	1	.31	.31		89	3115.	.715	. 222
74121	1	16.	-11		89	215	.715	222
74132	1	.64	.64		8	.120	120	ر ر ه
67121	1	1.24	1.24		9	.715	.715	.687
2N3646	1	.68	.68		9	.316	.316	.215
MPSA56	2	-17	.34		12	316	.612	107
CAP DISC.	15	113	1.95		75	. 291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	6,599	1.978
RESISTOR FC	7	.03	12.		35	.013	160.	.003
PHASE LOCK LOO	4	5.00	5,00		50	311.	.715	3.575
POTENTIONETER	1	.42	.42		15	.664	.664	975.
PC Board	1	2.00	2.00	818	25			_
MISC. HDW	LOT	.50	.50		20			
	4							
TYFALS			14.35	618	32941 1.5		18.482	(2.63)

SHEET 4 OF 8

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR	QTY	TINII	TOTAL.	LAPOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	QTY x FAIL, RATE
			1833	HANUFACTURING	ASSEMBLY	FAILURE RNTE	FAILURE	* UNIT CRET
MJE200	2	.57	1.14		16	1 970	976	
NJE1100	1	1.33	1.33				3: 340	7.240
MJE2801	1	1.33	1.33			1.970	026-1	2.620
IN4733A	-	20	02			1.970	1.970	2.620
			S.		5	. 786	. 786	. 157
IN4735A	-	82.	. 20		5	. 786	. 786	651
INC/42A	-	250	. 20		5	. 786	.786	167
IN52298	1	.15	.15		S	786	70,	
2N2222A	-	9.	.40		9	316	916	811.
SEN 30	2	98.	1.60		10	.155	016.	248
TRSTR, SI	-	. 15	.15		9	.316	.316	047
Diope, si	2	35	01.		01	. 155	.310	2
RESISTOR PC.	11	.03	.33		55			
RESISTOR MF	7	.37	.74		10		143	004
COIL	4	.12	.48		24	.046	1084	.047
CAP AL.	9	.84	5.04		,		.276	.031
CAP DC	10	11.	1.30			679.	3.774	3.170
TRANSFORMER	-	2.44	2.44		S		2.910	. 378
POTENTIONETER	7	88			40	866.8	8.998	21, 955
PC HOARD	-		00		30	. 644	1.328	1.116
		7.8	2.00	818	25		-	-
nist. How.	1 53	.50	.50		20		***	
SIT MTL.	101	. 50	.50	167	50	1		
TOTALS			22.41	386	425 x 1.5 (678)		29.57	35, 306
		•		_				

SYSTEM DABS with ELM UPLINK

ic Processor
LY Logs
SUB-ASSEMB

ITEM NAME OR CATERORY	δτΥ	TIMIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY x FAIL. RATE
		3	1883	NANUFACTURING	ASSEMBLY	FAILURE RATE	FATURE	x UNIT COST
7400	3	.24	.12		24	.120	360	780
7402	•	.24	%.		32	.120	480	311
7404	11	26	2.86		88	.715	7 865	700
7407	1	. 32	. 32		8	.715	715	228
240B	24	36	6.24		193	95.		
7432	7	.26	1.82		56	120	840	210
7478	11	18.	3.41		143	.715	7.865	2.438
7485	6	.84	7.56		72	.715	6.435	5.405
7486	9	.55	3,30		48	.120	.720	396
7491A	3	.92	2.76		24	.115	2,145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	-1	.65	.65		8	.715	.715	.465
74150	-	.97	.97		10	.715	215	694
74153	2	.72	1.44		16	.715	1.430	1.03
74154	1	1.07	1.07		12	.715	.715	. 765
74157	6	.72	6.48		90	. 715	6.435	4.633
74161	6	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	2115	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.13
74198	4	1.43	5.72		48	.715	2,860	4.090
741.521	7	.24	1.68		56	.060	420	ioi
TOTALS								101

SYSTEM DABS with ELM UPLINK

Sim-ASSPMIN Logic Processor

SHEET 6 OF

CATECORY	07.4	113	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	10TAL	OTY × FAIL. RATE
			- C	HANUFACTURING	ASSEMBLY	FAILURE	FATLURE	x unit ast
745271	1	1.29	1.29		100	316		
HCB504P	9	5.75	34.50		40			.922
MM74C910	-	1 4	1		95	://5	4.290	24.668
Pw16 co.	. .		7.40		8	.715	.715	5.291
67927		1.29	6.45		60	.715	3.575	4.612
NC556	7	-85	1.70		10	715		710
8048	-	7.50	7.50		20	507	507	2 803
MCM4027AC4	-	3.80	3.80		71		, in	3.603
TRSTR MPH	9	.14	.84		92	21.5	217.	2.717
Resistor	103	.03	3.09		515	200	666.	
Crystal	2	10.00	20.00		S	200	1.599	.048
						300	2.000	30.000
CAP Diec	۶							
300	₹	=	2.60		100	.291	5.82	757
PC Board	-	2.00	15.00	7664	100			
Misc. Udv.	İ	1.50	1.50		5			
					- 38-			
				1				
		-						
TOFALS			192.77	2664	2482 x 2 (4964)		100.487	125.557
				•		_	_	

SHELT 7 OF B

SYSTEM Beseline DABS Transponder SUB-ASSEMBLY Chassis & Enclosure

JTEN NAME OR CATEGORY	QTY	IN I	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. HATE
			Text	HANUFN TURING	ASSEMBLY	FATUURE	FALLURE RATE	* UNIT COST
PRONT PANEL				7.4	22		,	
CHASSIS	1			164	2			
TOP COVER	7	15.00	15.00	41	22		-	-
HOUNT	-			184	20			
BOTTON COVER	-			69	20			
PANEL PC BOARD	1	5.00	5.00	918	100			
CAVITY	-	30.00	30.00		225	200.000	200.000	6000 000
PRESELECTOR	-	7.50	7.50		50	1.16	1.180	B. 850
L.P. FILTER	-	3.00	3.00		25	22.844	11.844	35 512
POTENTIONETER	4	35.	35		15	.664	755	333
PUSH BT. SWITCH	-	. 50	.50		25	18.596	18.596	200
ROTARY SWITCH	-	1.68	1.68		100	4.415	4.415	7.417
LAMP	-	.62	4.34		100	25.856	180 992	112.215
24 PIN CONNECTOR	R 2	.95	1.90		50	1.128	2.256	. 141
MISC. NDW.	101	2.00	2.00		100			
SH'T METAL	101	3.00	3.00		200			
RF COMMECTOR	-	1.23	1.23		15		-	
FLEX CABLING	101	2.00	5.00		500		•	
CODE SHITCH	-	1.90	4.00		100	2.395	9.580	9.580
PC CONNECTOR	9	1.26	7.56		8			
TOTALS			92.06	1349	1823		429.527	6185.267 (64.80)

SHEET . 8 OF 8

SUB-ASSEMBLY ASSY, & Test

SYSTEM

ÇTY × FAIL. RATE × UNIT COST TOTAL FALLURE RATE UNIT FAILURE PATE LABOR HOURS PER 1000 UNITS ASSENBLY 50 120 25 100 200 200 2000 20 3 20 25 25 2 52 3575 **HANUFACTURING** TOTAL U.J.T COST OTY Ę ~ ITEM NAME OR CATEGORY Front Panel Preselector Logic BD 2 Per Supply Logic BD 1 Logic BD 3 Mod/Demod LP Filter Alignment Covers Burn-In IF Amp Cavity TOTALS Test

APPENDIX A-9

DABS WITH COMM A, B, AND C AND ATARS

(Discrete Version)

9 ö SHEET 1

SUB-ASSIVALLY ... IE ARELLEGE SYSTEM DABS Transponder

QTY # FAIL. RATE X UNIT CUST 695 . 244 .257 . 135 157 .136 4.462 361 104 2.72 130 .050 2.340 1.702 .676 TOTAL FAILURE RATE 786 . 786 .715 450 786 6.372 .316 5.720 . 316 316. .155 2.516 .320 13.095 1.650 .75 UNIT Failure Pate . 786 786 .715 .150 .786 2.124 316 316 .715 .715 336 629 .160 .155 .291 .550 LABOR HOURS PUR 1000 UNITS ASSEMBLY 0 0 2 15 5 18 9 ᄕ 46 2 و 9 225 15 MANUFACTURING TOTAL. 8 2 96 .20 7 7 6.24 8 ₹ 4 **Ŧ** 2 5.85 22 1.23 1.92 COST 8 8 8 20 .32 7 7 4 .3 .78 9 4 9 36 = 7 .03 QT. 80 5 3 ITEM NAME OR CATECORY RESISTOR A/C CAP. DISC. 5082-2835 DIODE, SI CAP. STO. CAP. CER. TSTR. SI **HPS6515** SPS6797 2N5086 CAP. T IN4151 MPSH10 IN4743 IN277 74121 7416

A-87

CRYSTAL

TOTALS FILTER

4.579

.041 . 266 12.000

. 950 . 345

1,500

5.127

.025

.832 12.720

.013 2.120 .069 .475 1.500 5.127

320

2 2 2 51 e

2.16

38 .12 8 8.00 .28

CHOKE COIL

9.

.56 8.00 8

~

COI. R

SHEET 2 OF 10

SYSTEM DABS Transponder

SUN-ASSPABLY __IF_AMBLICIET_(Cont'd)

ITEM NAME OR CATEGORY	OT.	UNIT	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	10TAL	Q'TY × FAI1 RATE
		e con	1000	MARIUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
TRANSF	9	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25			
HISC. HAV.	LOT	.50	.50		50			
SHT. MTC.	LOT	1,50	1,50	167	50		1	
TITALS			44.25	988	987 x 1.5 (1481)		70.342	35.445

ITEM NAME OR	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TI NO	TOTAL	QTY * FAIL. RATE
		93		HAPUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT CIST
7404	1	. 26	. 26		6	715	3115	301
7408	1	.26	. 26		8	120	120	150
7478	1	,31	.31		8	715	315	200
74121	1	16.	131		9		277	777:
74132	1	39.	64		0 00	67.	1 5	222
67121	1	1.24	1.24		9	715	315	7770
2N3646	-	89.	.69		9	.316	.316	215
MPSA56	2	.17	34		12	.116	6.7	107
CAP DISC.	15	.13	1,95		75	.291	4.365	.567
CAP VAR.	7	.23	.23		15	8.599	8,599	1.978
RESISTOR FC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOO	-	5.00	5.00		50	.715	3115	3.575
POTENTIONETER	1	.42	.42		15	.664	999	279
PC Board	1	2.00	2.00	818	25		,	
MISC. HOW	LOT	.50	.50		50		,	
TOTALS			14.35	818	329 x 1.5		18.482	(2.03)

SYSTEM DABS TRANSPONDER

SIG-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL	LAPOR HOURS PER 1000 UNITS	1000 UNITS	URIT	107AL	OTY × FAIL. RATE
			3	HANUFACTURING	ASSEMBLY	FATLURE	FAILURE RATE	x UNIT COST
MJE200	7	.57	1.14		16	1.970	040	,,,,,
MJE1100	-	1.33	11.11				200	7.740
MJE2801	-				8	1.970	1.970	2.620
2007777	. .	1.3	1.33		80	1.970	1.970	2.620
A55/141	-	8.	.20		2	. 786	. 786	.157
IN4735A	-	.20	. 20		ی	200		
IN4742A	-	. 20	. 20			300	997	157
IN5229B	-	.15	.15			96/	887.	- 157
ZN2222A	7	Ç	40		5	. 786	.786	.118
SER 30	7	a			9	. 316	.116	126
TRSTR. ST	-	3 3	1.60		10	. 155	. 310	. 248
2000	•	?	.15		9	. 316	.316	.047
olone, al	7	55.	.70		10	. 155	. 310	. 109
RESISTOR PC.	=	.03	.,,		55	013	:	
RESISTOR MF	2	.37	.74		90	1		900
COIL	4	. 12	. 48		24	280.	1084	740
CAP AL.	9	.84	5.04		25	600.		.031
CAP DC	3	1	02. [0,	679.	3.774	3.170
TRANSPOYMER	-				50	. 291	2.910	. 378
POTENTIONETER		,	2.44		40	8,298	8.998	21.955
2	•	20.	1.68		30	.644	1.328	1.116
rc Bowed	-	2.00	2.00	818	25		-	
Alac. HOW.	5	.50	.50		50		:	
SME MEL.	20	.50	. 50	167	50			
TOTALS			22.41	586	425 × 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with RIM UPLINK

SUB-ASSIMBLY Logic Processor

ITEN NAME OR	Qu	CMIT	TOTAL	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY x FAIL. RATE
CAI DOMES		cost	CUST	HANUFACTURING	ASSEMBLY	FAILURE	RATE	Tan X
7400	3	.24	.72		24	.120	. 360	.086
7402	4	.24	.96		32	.120	68 0	3115
7404	11	-26	2.86		88	311.	7.865	2.04
7407	1	.32	.32		8	3115	.715	. 229
2408	77	36	6.24		192	120	2.88	349
7432	7	92.	1.82		96	.120	.640	.218
7478	11	.31	3.41		143	.115	7.865	2.438
7485	6	9.	7.56		72	.ns	6.435	5.405
7486	9	.55	3.30		48	.120	.720	. 396
7491A		.92	2.76		>2	.115	2,145	1.973
74126	-	.44	.44		8	. 715	.715	.315
74136	7	.65	.65		8	.715	.71\$	\$94.
74150	-	.97	.97		10	. 715	.715	169 °
74153	~	.72	1.44		16	.715	1.430	1.03
74154	-	1.07	1.07		12	.715	.715	. 765
74157	6	.72	6.48		06	.715	6.435	4.633
74161	6	.54	4.86		8	.715	6.435	3.475
74164	,	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	7	. 79	1.58		20	S11.	1.430	1.13
74190	•	1.43	5.72		46	. 715	2,860	4.090
741.521	,	.24	1.68		56	.060	.420	101
rorals								

SYSTEM DABS with EIM UPLINK

Logic Processor	
SUB-ASSEMBLY	

ITEM NAME OR) to	TIND	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	10TAL	QTY × FAIL, RATE
CALEGORIE		CUST	UBI	HANUFACTURING	ASSEMBLY	PATE	RATE	IGN INO X
74\$271	1	1.29	1.29		100	. 715	21.5	. 922
MCB504P	9	5.75	34.50		48	215.	4.290	24.668
HH74C910	1	7,40	7.40		8	.715	.715	5.291
DM75S29	s	1.29	6.45		40	.715	3.575	4.612
NC556	2	.85	1.70		10	\$12.	1.430	1,216
8048	1	7.50	7.50		20	.507	. 507	3.803
NUM4027AC4	1	3.80	3.80		16	.715	.715	2.717
TRSTA MPH	9	. 14	.84	!	36	.316	1.339	.040
Resistor	103	.03	3.09		515	.013	1.599	.048
Crystal	2	10.00	20.00		20	1.500	3.000	30.000
CAP DISC	20	.13	2,60		100	162.	5.62	121.
PC Board	3	5.00	15.00	.66.4	100			
Hisc. Bdv.	ğ	150	1,50		50			
							1	
TUTALS			192.77	3664	24R2 × 2 (4964)		100.487	125.557 (5.62)

SHEET 7 OF 10

SYSTEM DAIS TRANSPONDER

SUB-ASSEMBLY ATABS

ITEN NAME OR	Ę	FIRS	TOTAL	LABOR HOURS PER	1000 UNITS	URIT	TOTAL	OTV × FAIL. RATE
CATEGORY		C06T	COST	HANUFACTURING	ASSEMBLY	FAILURE	RATE	x cert con
7400	. 5	.24	1.20		40	. 120	009	.144
7404	4	.24	%		32	.715	2.860	989
7408	10	.26	2.60		90	.120	1.200	510.
7416	2	.27	.54		16	120	240	065
7417	7	.27	1.89		96	.120	.840	.227
7432	7	.26	1.82		56	.120	. B40	. 218
7447A	8	.86	6.88		64	.715	5.720	4.920
7478		.31	2.48		64	-715	5.720	1.773
74138	1	.65	.65		80	.715	.715	. 465
74157	1	.72	.72		60	212.	315.	515
74164	7	.93	6.51		56	3.05	5.005	4.655
74166	8	.93	7.44		64	.715	4.720	5.320
741.521	2	.24	.48		16	.060	.120	.029
356	1	8	æ		œ	715	715	.686
SN74186	2	11.43	22.86		91	.715	1.430	16.345
CAP DISC	10	.13	1.30		90	.291	2.910	. 378
RESISTOR	20	.03	1.50		400	.013	.650	.020
LED DLY 6661	12	2.07	24.84		90	.715	8.580	17.761
LED HIMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED 00V36-3	91	.29	.64		80	.715	11.44	3.318
LED CQV 38-3	8	.30	2.40		40	.715	4,720	1.716
TYTALS								

SHEET 8 OF 10

SYSTEM DABS TRANSPONDER

SUR-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY x FAIL. RATE
			Town I	HANUFACTURING	ASSEMBLY	FAILURE	FALLURE RATE	x UNIT COST
P.C. BOARD	2	8.	8.00	1636	20			
MISC. HOW.	LOT	.50	.50		50			

TOTALS			104.67	1636	1354 × 1.5 (2031)		63.170	62.056 (4.42)

SYSTEM BASELINE DARS TRANSPONDER

Sta-Assmely Chastis & Enclosure

ITEM MANE OR	gr.	1145	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OT x FAIL. RATE
		183		HANUFACTURING	ASSEMBLY	PATE	FAILURE	A UNIT CUST
PROST PASEL	1			74	22			•
CHASSIS	1			184	7		•	
TOP COVER	1	15.00	15.00	14	22		•	
HOURT	1			184	20			•
BOTTON COVER	1			49	20	ı	,	•
CAVIT	1	30.00	30.00		225	200.000	200,000	6000, ∩00
PRESELECTOR	1	7.50	7,50		50	1.18	1.160	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIONETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	4	.50	.50		25	18.596	19.5%	9.298
ROTARY SWITCH	-	1.68	1.68		100	4.415	4.415	7.417
LAVE	4	.62	2.48		9	25.856	103.424	64.123
24 PIN CONNECTOR	R 2	.95	1.90		20	1.128	2.256	2.143
MISC. HOW.	101	2,00	2.00		100			
SH'T HETAL	TQ1	3.00	3.00		200	•	,	•
RF CONNECTOR	4	1.23	1,23		15	-	,	•
FLEX CABLING	103	5.00	5.00		200	•	•	_
THUMBINGEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	80	1.26	10.08		120		•	-
TOTALS			87.72	531	1713		151.959	(14.47)

SHEET 10 OF 10

ASSY. 6 Test

SUB-ASSMELY

OTY × PAIL. RATE × UNIT COST TOTAL FAILURE RATE UNIT FAILURE RATE LAROR HOURS PER 1000 UNITS ASSEMBLY S S 150 22 22 9 S S 200 52 88 8 2500 4300 25 HANUFACTURING TOTAL UNIT 2 E LITTER MANE OR CATEGORY Legic Bd 13 Logic Bd #2 ATARS BG 62 ATARS BO 11 Pront Panel Logic Bd #1 Preselector PAK SUPPLY Le rilter Mod/Demod Alignment Cavity 2 Durn-In TOTALS COVERS Test

APPENDIX A-10

DABS WITH COMM A, B, C, AND D
(Discrete Version)

SHEET 1 OF 9

STEM DABS Transponder

SUB-ASSEMBLY IF ANDLILLER

ITEM NAME OR CATEGORY	QTY	CWIT	TOTAL	IABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY * FAIL. RATE
				HANUFACTURING	KTUKESSY	FAILURE	FALLURE	x UNIT COST
7416	-	.89	88		8	786	784	607
74121	7	. 31	.31		60	786	784	246
1N277	7	, 36	36.		5	715	71.5	636
IN4151	3	. 30	96.		15	.150	450	Sti
IN4743	4	.20	.20		5	786	786	251
2N5086		-17	11.		18	2.124	6.372	.361
MP56515	4	.43	.43		9	.316	.316	.136
MPSH10	-	.33	.33		9	.316	.316	104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5062-2835		38	38		5	.715	27.	2.12
TSTR. SI	-	.41	.41		9	. 316	.316	130
DIODE, SI	4	.32	.32		5	.155	.155	050
CAP. STO.	4	-193	3.72		18	.629	2.516	2 240
CAP. CER.	7	. 36	17.		10	.160	. 320	3115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1,23		15	.550	1.650	929.
RESISTOR A/C	64	:03	1.92		320	.013	, 832	.025
CHOKE	9	. 36	2.16		36	2.120	12.720	4.579
COIL	5	21.	9.		30	. 069	. 345	.041
CO11. RF	2	.28	.56		12	.475	. 950	. 266
CRYSTAL	1	8.00	8.00		15	1.500	1,500	12.000
FILTER	-	.28	.28		9	5.127	5.127	1 476
TOTALS								

SYSTEM DABS Transponder

SUR-ASSEMBLY IF AMPLICATE (Cont.4)

TTEM MAME OF	2			and added to	2000			
CATEGORY	: >	TSW	TOI WIT	LABOR INORS FER 1000 UNITS	1000 00113	2011110	TOTAL	VII X FAIL. RATE
				HANUFACTURING	ASSEMBLY	INTE	RATE	
TRAKSF	9	. 38	2.28		40	2.309	13.054	5.265
PC Roard	1	4.00	4.60	818	25		'	
MISC. HOV.	TOI	,50	.50		20	1		
SHT. MTC.	101	1.50	1.50	167	50	ı		
TUTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445

SVSTEM DABS Transponder SUR-ASSEMBLY DESK DENOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
		3	Q .	HANUFACTURING	X78K3SSV	FAILURE	FAILURE RATE	x UNIT COST
7404	-	. 26	.26		a	316		
7408	1	. 26	.26		6	120	61)	186
7478	1	.31	117				0.1.	.031
74121	-	1			8	- 113	.715	.222
25 132	-	:			8	715	-715	222
1000	-	š	.64		8	.120	120	720
6/121	-	1.24	1.24		9	.715	.715	,887
2N3646	-	69	.68		9	.316	.316	. 215
MPSA56	2	-11	-34		12	316	633	20.
CAP DISC.	15	- 113	1.95		75	.291	4.365	267
CAP VAR.	-	.23	.23		15	8.599	8,599	1.978
RESISTOR FC	1	.03	.21		35	.013	160	003
PHASE LOCK LOOP	4	5.00	5.00		50	.715	77.5	35.5 1
POTENTIOMETER	1	.42	.42		15	.664	.664	229
PC Board	7	2.00	2.00	818	25	-		
MISC, HDW	101	. 50	.\$0		50			
	4							
TYTALS			14.35	818	32894) 1.5		18.462	92.53)

SHEET 4 OF 9

SYSTEM DANS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY - COMB A/B, C/D

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY x FAIL. RATE
		3	3	MANUFACTURING	ASSEMBLY	FAICURE	FATLURE	* UNIT COST
MJE200	2	.57	1.14		16	1.970	2 040	
MJE1100	7	1.33	1.33		0		25:	7.740
MJE2801	1	1.33	1.33		8	076.1	1.970	2.620
IN4733A	-	۶			9	1.970	1.970	2.620
	•	3	07.		5	. 786	. 786	.157
IN4735A	7	.20	.20		5	. 786	786	636
IN4742A	-	25	.20		5	. 786	786	751
IN5229B	7	.15	51.		٠	796		7511
2N2222A	1	04.	.40			937	. 786	.118
TRSTR, SI	1	.15	.15			. 110	.316	126
DIODE, SI	9	SE.	2.10			916.	.316	.047
					2	561.	.930	. 326
RESISTOR PC.	7	.03			55	.013	141	
RESISTOR MF	7	.37	.74		10	.042	200	800
ωιτ	4	.12	.48		24	060	1000	047
TYA - 1175.11	2	2.51	5.02		80	629	0/7:	.031
CAP DC	10	13.	1.30		9	Can.	1. 230	3.158
THANSFORMER	-	3.55	3.55		2	163:	2.910	. 378
POTENTIOMETER		184	1 68		40	8.998	8.998	31.943
PC BOARD	-	5	90 6		0.5	.644	1. 328	1.116
MISC. HIM.			4.00	818	25			•
	3	.50	.50		50			
SHT HTL.	101	.50	.50	167	50			
TOTALS			23.30	985	479 x 115 (719)		27.364	45.251

SYSTEM LIMES WITH COM N, 5, C and D	SUB-ASSEMBLY Logic Processor
	2
	Logic
Davi	PABLY
SYSTEM	SUB-ASS

ITEM NAME OR), Lo	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	QTY * FAIL, RATE
CALIBLORI		Teor	C(B)	HANUFACTURING	ASSEMBLY	RATE	RATE	1800
7400	3	.24	.72		24	.120	.360	980.
7402	4	. 24	8.		32	.120	. 480	311.
7404	14	92.	3.64		112	.715	10.01	2.603
2407	-	13	12		æ	715	7115	229
. 7408	28	. 26	7.28		224	.120	3.360	.874
7432	6	. 26	2.34		72	.120	.840	. 281
7478	13	.31	4.03		169	311.	9.295	2.882
7485	9	.84	7.56		72	317.	6.435	5.405
7486	9	.55	3.30		48	.120	. 720	. 3%
7491A	3	.92	2.76		24	21.5	2,145	1.973
74126	1	. 44	4.		8	517.	. 715	315
74138	1	.65	.65		8	.715	. 715	. 465
74150	1	.97	.97		10	.715	. 715	.694
74153	2	.72	1.44		16	.715	1.430	1.03
74154	1	1.07	1.07		12	.715	.715	. 765
74157	6	21.	6.48		06	317.	6.435	4.633
74161	6	.54	4.86		06	.715	6.435	3.475
74164	7	.93	6.51		95	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	61.	1.58		20	.715	1.430	1.13
74198	7	1.43	5.72		48	2115	2.860	4.090
741,821	7	.24	1.68		26	. 060	.420	.101
TOTALS	···							

SYSTEM DABS with Come A, B, C and D SUB-ASSEMBLY LOGIC Processor

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL	IABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV x F
				HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	× UNIT
748271	1	1.29	1.29		100	.715	.715	.922
MC8504P	9	5.75	34.50		48	715	4 200	937 46
M474C910	1	7.40	7.40		8	.715	.715	5. 291
DM75S29	5	1.29	6.45		40	715	3 876	
NC556	7	.85	1.70		10	317.	1.430	1.216
8039-11	-	18.65	18.65		20	.507	.507	9.456
8156	1	3.80	3.80		16	.715	.715	2 71.7
TRSTR NPN	9	411	.84		36	316	900	
RESISTOR	123	.03	3.69		615	.013	1.599	046
CRYSTAL	2	10.00	20.00		30	1,500	3.000	30.000
CAP DISC	30	.13	3.90		150	100	6	3
PC BOARD	3	5.00	15.00	2644	100	4277	67.78	25.1.1
TUTALS			214.18	2644	2622 x 2 (5244)		108.112	132, 728

LIFIER
¥
POMER
- ASSEMBLY
ġ

POWER AMPLIFIER	IER						
					•		
OTV.	J. I.W.	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTV × FAIL. RATE
	1900	190	PLANUFACTURING	ASSEMBLY	RATE	RATE	1000 I I I W
-	13.10	13.10		50	17.010	17.010	222.831
-	14.80	14.80		50	17.010	17.010	251.748
-	22, 50	22.50		0,5	35.215	35.215	792.338
-	39.60	39.60		50	176.077	176.077	6972.649
=	3.	1.82		70	. 291	4.074	.530
	21.	96		04	690`	. 552	990.
~	.03	.15		25	.013	.065	.002
~	2.85	2.85		40	.629	.629	1.793
-	2.34	2.34		40	,629	.629	1.472
1	15.00	15.00	818	50	١	, ,	•
1	1.35	1.35		25	•	_	•
_	2.00	2.00	167	44	•	•	•
-	0.50	. 50	42	22	•	•	1
202	0.50	S.		50			
		117.47	1027	909		251.261	8243.429 (147.64)
		╶╎╎╏╏╏┩┪ ┼┼┼┼┼┼┼┼┼┼┼┼┼┼┼	13.10 14.80 13.50 13.60 1.13 2.00 2.00 2.00 2.00 0.50 0.50	13.10 13.10 14.80 14.80 22,50 22.50 39.60 39.60 .13 1.82 .12 .96 .03 .15 2.85 2.85 2.34 2.34 15.00 15.00 8 1.35 1.35 2.00 2.00 2 0.50 2.00 2 0.50 .50 .50	13.10 13.10 14.80 14.80 22.50 22.50 39.60 39.60 .13 1.82 .13 .96 .03 .15 2.85 2.85 2.85 2.85 2.85 2.85 2.85 2.85 2.85 2.85 2.00 2.00 818 15.00 15.00 818 0.50 .50 42	13.10 13.10 50 17 14.80 14.80 50 17 22,50 22.50 35 39.60 39.60 50 176 .13 1.82 70 176 .13 1.82 70 176 .13 .18 40 40 2.85 2.85 40 40 15.00 15.00 818 50 15.00 2.00 42 25 2.00 2.00 42 22 0.50 .50 42 50 0.50 .50 42 50 117.47 1027 606	13.10 13.10 50 17.010 14.80 14.80 50 17.010 14.80 50 17.010 14.80 14.80 50 17.010 14.80 14.80 50 17.010 15.90 19.60

SYSTEM Beseline DABS Transponder SIB-ASSESLY Chasts & Enclosure

ITEM NAME OR	æ	באור	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	GTY x FAIL. RATE
CATEGORIE		183	rear	HANUFACTURING	ASSEMBLY	RATE	FALURE	x UNIT COST
PROST PASEL	1			74	22		,	,
CAMESIS	1			184	7			,
TOP COVER	7	15,00	15.00	41	22		,	
NOUNT	1			184	20	-		,
BOTTON COVER	1			48	20		,	,
PANEL PC BOARD	1	5.00	5.00	818	100			
PRESELECTOR	1	7.50	7.50		0%	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.644	11.844	35.532
POTENTIONETER	-	.35	. 35		15	.644	.664	.232
PUSH ST. SWITCH	1	. 50	. 50		25	18.596	18.596	9.298
MOTARY SMITCH	1	1.68	1.68		100	4.415	4.415	7.417
2477	7	.62	4.34		100	25.856	180.992	112.215
24 PIN COMMECTOR	2	.95	1.90		05	1.128	2.256	2.143
MISC. MOM.	LOT	2.00	2.00		100		,	
SB'T METAL	LOT	3.00	3.00		200		,	
RF COMMECTOR	1	1.23	1.23		15	,	•	ŧ
FLEX CALLING	5	5,00	5.00		200	1		
CODE SWITCH	4	1.00	4.00		100	2,395	9.580	9.580
PC COMMECTOR	•	1.26	7.56		06			
TOTALS			62.06	1349	1598		129.527	185,267 3,63

SUB-ASSERLY ASSY.	1991						SHEET . 9	OF 9
ITEM NAVE OR	Ĕ	TIME	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TCTAL	ÇIY × FAIL. RATE
CATEGORY		COST	COST	HANUFACTURING	ASSEMBLY	FAILURE	FATLURE	x UNIT COST
IF Amp	1				50			
Mod/Dussed	1				90			
Pur Supply	1				150			
Processor 81	1				25			
Processor 82	~				25			
Processor 63	1				25			
Power Amp	1				125			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covera	Lot				25			
Alignment	•				200			
Ourn-In	-				200			
Test	•				2000			
TOTALS					3600			

BASIC DABS (ISI Version)

ĕ	
Š	l
3	1
F	l
Ž	
Ē	•

ITEN MANE OR	010	TIM	TOTAL	LABOR HOURS PER 1600 UNITS	1000 UNITS	UNIT	TOTAL	OTY x FAIL. RATE
CATEGORY		58	1900	MANUFACTURING	ASSEMBLY	RATE	RATE	1000 1100 4
7416	1	96	98		69	. 786	. 786	.692
74121	1	.31	. 31		8	. 786	. 786	.244
10277	1	Ŋ,	96.		S	.715	.715	.257
114151	-	.30	8.		15	. 150	.450	.135
IM4743	-	.20	. 20		S	.786	. 786	.157
2N5086	•	.17	.17		18	2.124	6.372	. 361
MPS6515	1	141	.43		9	. 316	. 316	.136
MPSH10	1	.33	.33		9	.316	316.	. 104
76L9S4S	8	94.	6.24		48	.715	5.720	4.462
5082-2835	1	38	98		S	.715	.75	2.72
TSTR. 81	1	.41	.41		v	. 316	316	.130
Dicog. 81	1	.32	.32		\$,155	.155	050
CAP. STO.	•	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	36	.72		10	. 160	. 320	311.
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	. 550	1.650	.676
RESISTOR AC	64	.03	1.92		320	.013	.832	.025
CHOKE	9	%.	2.16		36	2.120	12.720	4.579
COLL	5	.12	99.		30	690.	.345	140.
COIT ME	2	.20	. 56		12	.475	. 950	. 266
CHYSTAL	-	9.90	8.00		15	1.500	1,500	12.000
FILTER		98.	. 28		9	27.5	5.127	1.4%
TUTALS					·			

SYSTEM DABS Transponder

SIM-ASSEMBLY IF ANDLIGIER (Cont'd)

LITEM NAME OR CATEGORY	סדע	1 N 1 4	TOTAL.	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY x FALL. RATE
		877	93	NAPIUI'ACTURING	ASSEMBLY	FATURE	FALURE	x UNIT COST
TEAMS	9	. 36	2.28		40	2.309	12.964	200
PC Board	1	4.00	4.00	818	25		PC0:03	2.403
MISC. Hbv.	101	,50	.50		50			
SHT. MTC.	101	1,50	1,50	167	05			
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

YSTEA	DABS Transponder	
	Ę	

SHIM- ASSEMBLY DPSK DEHOD. / PPH HOD.

TTEN NAME OR) Lib	TIND	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	TY x FAIL. RATE
CATEGORY		CUST	COST	HAUUFACTURING	ASSEMBLY	INTE	RATE	L COL
7404	1	. 26	.26		8	. 715	5112	, 186
7408	1	.26	.26		8	.120	.120	160.
7478	1	18,	.31		8	.715	. 715	.222
74121	4	Tr.	187		œ	215	-2115	222
74132	1	9.	.64		8	.120	.120	720.
67121	1	1.24	1.24		9	.715	.715	. 887
2N3646	7	89.	.68		9	. 316	. 316	.215
MPSAS6	2	.17	.34		12	.316	.612	107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8,599	1.978
RESISTOR PC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOOP		5.00	5.00		50	.715	.715	3,575
POTENTIONETER	1	.42	.42		15	,664	.664	.279
PC Board		2.00	2.00	818	25	,	•	•
MISC. NDW	TOI	.50	.50		50	•	,	-
	4							
TOTALS			14.35	818	32894) 1.5		19.482	82.343)

"TP-ASSPABIN POMER SUPPLY

1								
TILM HAMI: OR	770	TIND	ToTAL	LANDE LOURS PUR 1000 UNITS	1000 UNITS	TINO	TOTAL	OTV × FAIL. RATE
		9		MACOUALTUBING	ASSEMBLY	INTE INTE	RATE	igo imo c
NJE200	2	.57	1.14		91	1.970	3.940	2.246
MJE1100	2	1.33	2.66		16	1.970	3.940	5.240
IN4733A	7	,20	.20		5	786	786	.157
1N4735A	~	. 20	. 20		\$	786	786	157
In4742A	1	. 20	. 20		s	. 786	.786	157
IN\$2298	7	.15	. 15		5	. 786	. 786	118
2N2222A		04.	.40		9	3,6	Air	201
SEM 30	2	.80	1.60		10	.155	OIE.	248
TESTR. SI	1	.15	21.		9	316	316	270
15 '30010	2	. 35	٥٢.		10	,155	310	921
RESISTOR FC.	n	.03	.33		55	610.	.143	700
RESISTOR MF	2	.37	.74		10	042	- 88.	047
πω	4	.12	. 48		24	690.	. 276	.031
CAP AL.	1	.84	2.52		18	.629	1.887	1,585
CAP DC	10	.13	1.30		50	. 291	2, 910	378
TRAMSFORMER	~	2.44	2,44		40	8.998	8.998	21.955
POTENTIONETER	7	.84	1.68		30	. 664	1.328	1.116
PC. BOARD	-	2.00	2.00	818	25			•
MISC. HOW.	LOT	.50	. 50		50			
SIFF HFL.	5	.50	20	167	50	-		
	1	}	İ				-	
rotals			19.89	985	436 x 1.5		27.64	13.721

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Main PC Board

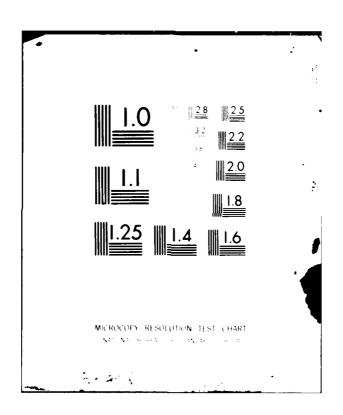
	The second second							
ITEM NAME OR CATEGORY	λιδ	TINI	TOTAL	LABOR WOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV × FAIL. F'TE
		3	L GOOD	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE RATE	× UNIT COST
7400	1	.24	.24		œ	950	96.	
7402	3	.24	51.		24		250	670.
7404	9	.26	1.56		40		OBE:	980
7408	2	.26	.52		16	230	7.080	.281
7432	1	.26	. 26			130	007.	290.
7479	7	11	.62		3,6	316	031	150.
74161	3	.54	1.62		24	2115	2 148	. 443
74166	9	.93	5.58		48	715	7 290	1.136
741.521	1	.24	.24		0	090	36	3,350
NC 556	2	.85	1.70		91	715	230	\$10°
181	3	10.00	30.00		09	717	06.1	0 510
LSI Timing	1	5.00	5.00		20	.211	112	7,240
TSTR MPW	9	.14	.84		36	.316	7.896	265
Resistors	3	.03	2.62		470	.013	1.222	037
Capacitors	10	.13	1.30		50	.629	6.290	818
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
PC Board	1	5.00	5.00	918	25			
Misc. Hdv.	lot	.50	.50		50			
151 Socket	+	1.25	5.00		80		,	
TOTALS			73.52	818	1016 x 2 (2032)		23.345	13:35

SVSTEM BASELLAGA DARS Transconder SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR	μō	1185	TUTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	חאות	TOTAL	QTY & FAIL. RATE
			1000	HANUFACTURING	ASSEMBLY	RATE	FAILURE	x UNIT COST
PRONT PANEL	1			74	22			
CHASSIS	-			184	*			,
TOP COVER	1	15.00	15.00	41	22			,
HOUNT	1			184	20			
BOTTON COVER	7			48	20	-		-
PANEL PC BOARD	1	2.00	5.00	918	100	•		-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	~	7.50	7.50		50	1.18	1.180	6.850
L.P. PILTER	-	3.00	3.00		25	11.844	11.844	35.532
POTENTIONETER	7	. 35	.35		15	199.	.664	. 232
PUSH BT. SWITCH	-	.50	.50		25	18.596	18.596	9.298
ROTARY SMITCH	-	1.68	1.68		100	4.415	4.415	7.417
LAMP	1	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTUR	2 2	26.	1.90		90	1.128	2.256	2.143
MISC. HDM.	101	2.00	2.00		100	-		,
SH'T METAL	103	3.00	3.00		200			
RF CONNECTOR	-	1.23	1.23		15	1		-
PLEX CABLING	101	5.00	5.00		500	-		-
CODE SMITTCH	Ψ.	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		09			
TUTALS			89.54	1349	1793		429.527	6185.267 (64.80)

QTY x PAIL. RATE x unit cost , or TOTAL FAILURE RATE SHEET UNIT Failure Rate LABOR HOURS PER 1000 UNITS ASSEMBLY 20 20 8 150 25 3 3 % 500 200 2 1000 2525 HANUFACTURING TYTAL UNIT COST SUM-ASSEMBLY ASSY. L. Tubet QTY ᅧ Processor Boar ITHM NAME OR CATECORY Preselector Front Panel PAT SUDDIY Mod/Ivenod LP Filter Aliquent Cavity Burn-In Covers Trans Test

ARINC RESEARCH CORP ANNAPOLIS MD F/6 17/7
COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)
SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-37AB
126-01-15-2529
DOT/FAA/RD-81/61
MI AD-A112 957 UNCLASSIFIED NL. 3 or 4



BASIC DABS WITH ANTENNA DIVERSITY (LSI Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IR Amplifier

ITEM NAME OR	QT.	TIM	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	CATTURE	10174	A UNIT COST
CATECORY			r and	MANUFACTURING	ASSEMBLY	RATE	RATE	
7416	-	88.	88.		8	. 786	. 786	.692
74121	~	£.	18.		80	. 786	. 786	. 244
1N277	-	38,	. 36		S	. <u>n</u> s	3115.	.257
INAISI	٠	S.	6 .		15	. 150	.450	.135
IN4743	-	02.	.20		5	. 786	. 786	.157
	3	11.	۲۱.		18	2.124	6.372	. 361
	1	.43	.43		9	. 316	.316	.136
MPSH10	1	.33	.33		9	. 316	. 316	104
5PS6797	8	. 78	6.24		48	. 715	5.720	4.462
5062-2835	1	.38	. 38		S	.715	.75	2.72
TSTR. SI	1	. 11	.41		9	.316	316	.130
DIODE. SI	-	.32	. 32		S	.155	,155	050
CAP. STO.	•	.93	3.72		18	.629	2,516	2.340
CAP. CER.	2	. 36	.72		10	.160	. 320	.115
CAP. DISC.	45	.13	5.85		225	. 291	13.095	1.702
CAP. T	3	.41	1.23		15	. 550	1.650	929.
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	9	. 36	2.16		36	2.120	12.720	4.579
COLL	2	.12	09.		30	690.	. 345	.041
COIL RF	2	. 28	95.		12	.475	. 950	. 266
CRYSTAL	1	8.00	8.00		15	1.500	1,500	12.000
PILTER	1	.28	82.		9	5.127	5.127	1.436
THAIS								

SVSTED DARS Transponder SUB-AGSEDELY IL AMPLISTEE (CORE 'd)

Q.Y x FAIL. RATE x UNIT COST 5.265 35.445 10TAL Failure Rate 13.854 70.342 UNIT Failure Rate 2.309 LANOR HOURS PER 1000 UNITS ASSEMBLY 987 x 1.5 (1481) \$ 2 S 짌 MANUFACTUR IN: 918 791 962 TUTAL. 2.28 8 20 1.50 44.25 THE 2 4.00 250 1.50 101 703 ž ITEM NAME OR CATEGORY MISC. HAV. SHT. HTC. PC Board TRANSF TOTALS

SHEET 3 OF 7

SYSTEM DABS Transponder

SUB-ASSIMBLY DESK Demod./PPM. Mod. & Diversity Switch

ITEM NAME OR CATEGORY	gr.	T180	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	QTY x FAIL. RATE
		3	333	HANUFACTURING	ATHRESSY	FAILURE RATE	FALURE	x UNIT (XST
7404	7	.26	. 26		0	.715	716	70.
7408	2	.26	.52		16	.120	240	250
9192	4	.31	ιε.		ø	.715	.715	222
74121	2	.31	.62		16	.715	1.430	443
74132	4	39.	164		8	.120	120	210
67121	1	7.7	2.40		12	715	1 430	. 333
282857	4	1.10	1.10			3.6	316	
2N3646	7	89.	1.36		12	33.6	617	130
2H3B66	7	1.24	1.24		9	.316	316	302
NP2000	7	28	. 84		.2	.155	110	
LASTER	4	2.10	2.10		8	.715	215	2 503
MPSA 56	+	71.	.68		24	. 316	1.264	215
CAP DISC	×	.13	4.42		170	.291	9.894	306.1
CAP VAR	+	.23	.23		15	8.00	6 500	00314
RESISTOR, PC	Q *	.03	1.20		200	.013	520	016
COIT	•	.28	1.12		24	690	.276	720
PHASE LOCK LOOP	7	5.00	5.00		50	.715	215	1 626
POTENTIONETER	2	24.	.84		Q.	999	328	253
PC. BOARD	-	2.00	2.00	918	25			725
MISC. HDW.	101	.50	.50		50			
TOTALS			27.46	818	74080}.5		29.535	13.269 (2.02)
							_	

OTY & FAIL, KATE & INIT CHEE

TOTAL FAILURE RATE 2.246 5.240 157

3.940

SYSTIM DASS TRANSPONDER

WILL MASSING NOTICE SUPPLY

CATECOLY	OTY.	UNIT	TITAL.	LARUR LICHES PER 1000 UNITS	1000 UNITS	URIT
		le m		IMERITACITURE ING	ASSEMBLY	FAILUNE
KJE200	2	.57	1.14		16	1.970
30E1100	2	1.33	2.66		16	1.970
EM47 33A	1	720	. 20			ğ
EM4735A	7	. 20			5	787
IN4742A	1	. 20	.20		5	786
FN\$2298	-	. 15	.15		2	786
2N2222A	1	40	0		,	316
SER 30	2	9	1.60		10	351
Thath. St	1	.15	.15			200
P100E, 51	2	.35	٥٤.		10	155
RESISTOR PC.	11	.03	. 33		55	
NESISTOR MF	2	.37	٠74		10	3
Soil.	4	.12	.48		24	990
CAP AL.	2	26.	2.52		18	629
CA BC	10	.13	1.30			
TRAISPORKER	ι	2.44	2.44		96	2000
POTENTIONETER	2	184	1 60		2	0.220

251.

387. 387. 318. 018. 9

310

4

.143

.031

276 1.887 2.910 8.998 1.328

21.955

.664

ł

3 2 3 3

2.00

8 3

5 5

2.00

POTENTIONETER
PC. BOARD
MISC. HDM.

167

2

13.721 (\$5.49)

27.64

436 x 1.5 (654)

985

19.89

TALS

SYSTEM Beseline DABS Transponder

Main PC Board	
B-ASSEMBLY	

ITEM NAME OR CATEGORY	QTY	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY * TAIL. RATE
			3	HANUFACTURING	ASSEMBLY	FAILURE	FAT LURE RATE	x UNIT COST
7400	1	.24	.24		60	.120	120	620
7402	3	.24	.72		24	120	360	Yes
7404	9	.26	1,56		48	.180	1.080	.201
7408	2	. 26	.52		16	.120	.240	.062
7432	1	.26	-26		9	.120	.120	.031
7479	7	T.	-62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	٥	.93	5.58		48	.715	4.290	3.990
741521	-	.24	.24		8	.060	090	-014
NC 556	7	-85	1.70		10	.715	1.430	1.216
181	C	10.00	30.00		09	716.	.951	9.510
LSI Timing	~	5.00	5.00		20	.211	.211	1.055
TSTR HPH	٥	114	.84		36	. 316	1.896	. 265
Mediators	26	:03	2.82		470	.013	1.222	.037
Capacitors	10	.13	1.30		50	.629	6.290	.618
Crystal	~	10.00	10.00		15	1.500	1.500	15.000
PC Board	~	5.00	5.00	618	25			,
Misc. Bdv.	Lot	.50	.50		50		•	
ISI Sochet	4	1.25	5.00		80			
TOTALS			73.52	818	1016 x 2 (2032)	í	23.345	33.885

SUB-MSSERLY Changla & Enclosure

ITEM MANE OF	F	TIME	TOTAL	JABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE × IMIT COST
		iem	1833	HANUFACTURING	ASSEMBLY	RATE	Rite	
PROME PANEL	ı			74	22	•	ű	•
CHASSIS	1			164	77			
TOP COVER	1	15,00	15.00	41	22	•	•	-
HOUSE	l			184	20	٠		•
BOTTON COVER	1			48	20	٠	•	4
PANEL PC BOARD	1	5.00	5.00	918	100		_	4
CAVITY	2	30.00	60.00		450	200.000	400.000	12000.000
PRESELECTOR	2	7.50	15.00		100	1.18	2.360	17.700
L.P. FILTER	2	3.00	6.00		50	11.644	23.688	71.064
POTENTIONSTER	1	×	χ.		15	₹99*	.664	.232
PUSH BT. SWITCH	1	. 50	.50		25	16.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LANP	,	.62	4.34		100	25,856	180.992	112,215
24 PIN CONNECTOR	R 2	8	1.90		20	1.128	2.256	2.143
MISC. HDMS.	101	2.00	2.00		100		•	0
SH'T NETAL	101	3.00	3.00		200	•		-
RE CONNECTOR	2	1.23	2.46		30		•	
FLEX CABLING	Ę	5.00	5.00		500			
CODE SWITCH	4	1.00	4.00		100	2,395	9.580	9.580
PC COMMECTOR	2	6.30	7.56		75	,		•
							•	
torals			132.53	1349	2123		642.551	12,229.649 (85.65)
								-

ITEN NAME OR	QTY	1180	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	CRIT	TOTAL	QTY × PAIL. RATE
			Ign	MANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
IP AMP	2				100			
Mod/Demod	1				75			
Per Supply	1				150			
Processor Boar	1				25			
Cavity	7				200			
Preselector	7				100			
LP Filter	2				100			
Front Panel	1				25			
Covers	lot				25			
Allement					609			
Burn-In	,				200			
Test	-				1000			
TOTALS					2900			

BASIC DABS WITH 21.5 dBW AT ANTENNA (LS1 Version)

ITEM NAME OR	סנג	TINU	TOTAL	STINU 0001 RER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL, RATE
		I GID	i ens	MANUFACTURING	ASSEMBLY	ratuder. Rate	RATE	TSU LIMI X
7416	1	88	.88		8	. 706	. 786	269.
74121		.31	.31		æ	. 786	. 786	.244
1N277	1	, 36	. 36		2	. 115	.715	752.
184151	3	.30	8.		15	. 150	.450	261.
IM743	4	.20	.20		S	. 786	. 786	.157
21:5086	3	.17	11.		18	2.124	6.372	. 361
NPS6515	-	.43	.43		9	. 316	.316	7££.
MPSH10	7	.33	. 33		9	.316	. 316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		5	317,	27.	2.72
TSTR. SI	-	41	141		9	. 316	. 316	.130
DIODE, SI	4	27.	.32		5	. 155	.155	050,
CAP. STO.	4	.93	3.72		18	.629	2.516	2,340
CAP. CBR.	7	. 36	.72		10	.160	. 320	311.
CAP. DISC.	\$.13	5.85		225	.291	13.095	1.702
CAP. T		4	1.23		15	.550	1.650	. 676
RESISTOR A/C	3	:03	1.92		320	.013	.832	.025
CHOKE	9	36	2.16		36	2.120	12.720	4.579
COIL	2	21.	99.		30	690.	. 345	160.
COIL RE	2	.28	.56		12	.475	.950	. 266
CRYSTAL	-	9.00	B .00		15	1.500	1,500	12.000
FILTER	-	.28	.28		9	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SUR-ASSEMBLY IF AND	molifier	lifler (cont'd)	ļ					
ITEM NAME OR	Æ	TINO	TOTAL	Labor Hours per 1000 units	1000 UHITS	TINO	10TAL	OTY x FAIL. PATE
CATBLONI		LSOS	CUST	HAMUFACTURING	ASSEMBLY	RATE	RATE	A UNIT CUST
TRANSF	9	.38	2.28		40	2.309	13.854	5.265
PC Board	7	8.9	4.00	818	25	•	•	ŧ
HISC. HOW.	101	05,	.50		50	•	•	_
SHT. MTC.	LOT	1.50	1,50	167	50	-	•	6
TYTALS			44.25	586	987 × 1.5 (1481)		70.342	35.445

SYSTEM DABS Transponder

£00	
/PPM	
DEMOD.	
UPSK	
B-ASSPABLY	

ITEM NAME OR	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	QTY x FAIL. RATE
		em	1913	HANULACTHRING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7404	4	.26	.26			715	31.6	
7408	1	. 26	.26		8	120	120	180
7478	1	,31	.31		8	715	315	
74121	4	. 31	.31				611)	
74132	7	.64	.64		a	130	215	222
67121	1	1.24	1.24		9	715	215	770
2N3646	1	89.	.68		9	.316	. 316	188,
MPSA56	~	.17	.34		12	116	613	
CAP DISC.	15	:13	1.95		75	. 291	4.365	567
CAP VAR.	-	.23	.23		15	8.599	8,599	1.978
RESISTOR PC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOOF	1	5.00	5.00		- 50	.715	315	1 675
POTENTIONETER	1	.42	.42		15	.664	.664	279
PC Board	1	2.00	2.00	818	25			
MISC. HDW	LOT	.50	.50		50			,
	1							
TOTALS			14.35	818	328.41.5		18.482	(2,343)

ITEM NAME OF	QT.Y	THE	TOTAL	LABOR LOURS PER 1000 UNITS	1000 UNITS	UNIT	101AL	QTY # FAIL. EATE
		e e	CENT	FLANUE'AC LEIR ERG	ASSESSIBLY	PALLURE PATE	RATE	TEO K
MJE200	2	15.	1.14		16	1.970	3.940	2.246
ME1100	1	1.33	1,33		€.	1.970	1.970	2.620
MJE2801	1	1.33	1.13		6	1.970	1.970	2.620
IN4733A	1	. 20	. 20		S	. 786	. 786	151.
IN4735A	1	. 20	. 20		\$	786	. 786	157
IH4742A	1	. 20	. 20		S	. 786	. 786	.157
11152298	-	.15	.15		5	. 706	. 786	.116
ZN2222A	7	.40	.40		9	316	,316	.126
SEM 30	7	. 90	1.60		10	.155	016.	.248
TRSTR, SI	-	. 15	.15		9	316.	.316	.047
DIODE, SI	7	. 35	۰۲۵		10	. 155	.310	. 109
RESISTOR PC.	11	.03	Ε.		55	011	141	004
RESISTOR MF	7	78.	٠74		10	.042	.084	.047
COIL	4	.12	.48		24	690.	. 276	160.
CAP AL.	4	.84	3.36		24	.629	2.516	2.113
CAP DC	10	.13	1.30		90	. 291	2.910	. 378
TRANSFORMER	7	2.44	2.44		40	8, 998	8.998	21.955
FOTENTIOMETER	7	.84	1. 68		30	.644	1. 328	1.116
PC BOARD	1	2.00	2.00	818	25			;
MISC. HDW.	LOT	.50	ns.		8	:	-	
SHE MIL.	16.1	05.	05.	167	50			
	-							
TOTALS			20.73	985	442 x 1.5 (u.63)		28.269	34,249 (5,45)

SYSTEM Baseline DABS Transponder

PC Board	
Te in	
SUB-ASSEMBLY	

ITEM NAME OR CATEGORY	A10	TIMI	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY * FAIL. RATE
		er.		HANUFACTURING	ASSEMBLY	FAILURE	FATI-URE RATE	x UNIT COST
7400	-	.24	.24		8	120	120	960
7402	1	.24	.72		24	120	350	900
7404	9	.26	1.56		48	100	1 000	200
7408	7	.26	.52		16	3	000.1	197
7432	1	. 26	.26		•	130	25.	790.
7478	2	12	.62		, y	315	. 120	160.
74161		. 54	1.62		24	311	2 146	
74166	9	.93	5.58		48	315	4 200	1.138
741.521	1	.24	.24		8	000	8	3.990
NC 556	~	.85	1.70		01	316		\$10.
151	3	10.00	30,00		90	111	11430	1.216
LSI Timing	1	5.00	5.00		20	.211	112	1.065
TSTR NPN	9	11.	.84		36	.316	1.896	266
Resistors	8	.03	2.82		470	.013	1, 222	210
Capacitors	01	.13	1.30		50	.629	6.290	BIB
Crystal	-	10.00	10.00		15	1.500	1.500	15,000
PC Board	-	5.00	5.00	618	25	-		
Misc. Hdw.	Lot	.50	.50		90			
ISI Socket	+	1.25	5.00		90			
TOTALS			73.52	818	1016 x 2 (2032)		23.345	12:335

SHEET 6 OF 7

SVSTEM BASSLIDE DASS Transponder SUB-ASSEMBLY Chassis 6 Enclosure

CATEGORY	È	1180	TUTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OTY * FAIL. PATE
			<u> </u>	PIANUFAC.TURING	ASSEMBLY	FAILURE	FATLURE	x UNIT CUST
FRONT PANEL	1			74	22			
CHASSIS	1			184	44			,
TOP COVER	7	15.00	15.00	17	: :			,
MOUNT	-			184	**			,
BOTTOM COVER	-			48	07		•	-
PANEL PC BOARD	1	5.00	5.00	818	2 2		-	
CAVITY	1	30.00	30.00		225	- 000		
PRESELECTOR	1	7.50	7.50			200.000	700.000	6000.000
L.P. FILTER	1	3.00	3.00		2	07.1	1.180	9.850
POTENTIONETER	-4	2	36		C)	11.844	11.844	35.532
PUSH BT. SWITCH	-	5	3		15	.664	664	.232
			OC.		25	18.5%	18.596	9.298
NOTARE SWITCH	7	1.68	1.68		100	4.415	4.415	7.417
	-	.62	4.34		100	25.856	180 ogs	
24 PIN CONNECTOR	R 2	.95	1.90		\$0	1 130	100.332	112.215
MISC. HDW.	LOT	2.00	2.00		100	- 1	7.236	2.143
SH'T METAL	101	3.00	3.00		36		<u> </u>	
RF COMMECTOR	1	1.23	1.23		3.	•	•	-
FIEX CABLING	1 51	5.00	5.00		500		•	•
CODE SWITTER	•	2.00	8.		000		•	-
PC CONNECTOR		7			100	2, 395	9.580	9.580
		2	3.04		99			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)

SHEET 7 OF 7

SUR-ASSEMBLY ASSY. L Test

OTY × FAIL. RATE × UNIT (UST TOTAL FAILURE RATE UNIT FAILURE RATE LABOR HOURS PER 1000 UNITS ASSEMBLY 150 8 25 8 S S 500 50 1000 22 ন 2525 MANUFAC'TURING TOTAL. COST ğ Processor Boar ITEM NAME OR CATEGORY Preselector Front Panel Par Supply LP Filter Hod/Demod Alignment Burn-In Cavity IF Amo Covers TITALS Test

DABS WITH COMM A AND B

(LSI Version)

ITEM NAME OR CATEGORY	QTY	TIM	TOPAL.	LANOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	107AL.	QTV × PAIL. RATE
			3	HAMUFACTURING	ASSEMBLY	PATE	RATE	x UNIT CUST
7416	7	89.	-88		9	.786	. 786	.692
74121	1	16.	.31		8	. 786	. 786	.244
IN277	4	.36	36		5	.715	.715	.257
114151	3	.30	96.		15	. 150	.450	.135
IN4743	1	.20	.20		5	. 786	. 786	.157
2N5086	3	117	11.		18	2.124	6.372	. 361
MPS6515	4	.43	.43		9	.316	316	.136
MPSH10	-	.33	.33		9	.316	.316	.104
2PS6797	8	. 78	6.24		40	.715	5.720	4.462
5082-2835	1	38	38		5	.715	57.	2.72
TSTR. SI	-	. 41	.41		9	. 316	. 316	130
plube, st	-	32	.32		5	.155	. 155	050'
CAP. STO.	+	183	3.72		18	.629	2.516	2.340
CAP. CER.	2	×.	.72		10	.160	. 320	.115
CAP. DISC.	45	:13	5.85		225	. 291	13.095	1.702
CAP. T	-	.41	1.23		15	. 550	1.650	919.
RESISTOR A/C	3	.03	1.92		320	.013	.832	\$20.
CHOKE	9	.36	2.16		36	2.120	12.720	625.4
COIL	2	.12	.60		30	690.	.345	.041
COIL RF	2	.28	.56		12	.475	. 950	. 266
CRYSTAL	4	8.00	8.00		15	1.500	1,500	12.000
PILTER	7	.28	.28		9	5.127	5.127	9.7 1
TOTALS								
				-	_			

SHEET 2 OF 7

SYSTEM DABS Transponder

sur-mismun If Amplifier (Cont'd)

LITEN NAME OR CATEGORY	æ	UNIT	TOPAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	1190	TOTAL	QTV × FAIL. BATE
			3	HANUFACTURING	ASSEMBLY	FATURE RATE	FALUNE	× UNIT COST
TRAMSF	9	.38	2.28		0	2, 200	13.06	
PC Board	1	4.00	4.90	918	25		10.00	5.265
MISC. HOV.	101	,50	.50		\$0			•
SHT. MTC.	101	1.50	1.50	167	9			
							-	
	1							
TITALS			44.25	586	987 × 1.5 (1481)		70.342	35.445

SYSTEM DABS Transponder

SHB-ASSEMBLY DPSK DEMOD./PPH MOD.

ITEM NAME OR	OTV	FIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTV × FAIL. RATE.
CATEGORY		₩.	1.500	MANUFACTURING	ASSEMBLY	RATE	RATE	
7404	-	.26	.26		80	\$17.	311,	. 186
7408	-	. 26	. 26		8	.120	.120	.031
7478	1	11.	.31		80	.715	.715	. 222
74121	1	F	77		80	2115	2115	222
74132	1	.64	19.		60	.120	120	
	1	1.24	1.24		9	.715	.715	.887
	1	89.	.68		9	.316	.316	.215
MPSA56	2	.17	.34		12	316	7.9	107
CAP DISC.	15	.13	1.95		75	. 291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8,599	1.978
RESISTOR FC	,	.03	.21		35	.013	160	.003
PHASE LOCK LOOP	1	5.00	5,00		50	2115	.715	3,575
POTENTIONETER	-	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	TOT	.50	.50		50	•	•	•
	<u>.</u>							
TYTALS			14.35	818	329.4, 1.5		18.482	(2.33)

SHEET 4 OF 7

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR	QTY	TIND	TOTAL	LAPOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	QTY x FAIL. RATE
			ton,	MANUFACTURING	ASSEMBLY	FAILURE	RATE	x Gait Cres
NJE200	2	.57	1.14		16	1.970	3.940	2.246
NJE1100	1	1.33	1,33		6	1.970	1.970	3 620
MJE2801	1	1.33	1.33		8	1.970	1.970	2 620
IN4733A	1	. 20	.20		5	. 786	. 786	.157
IN4735A	1	. 20	. 20		5	786	786	16.7
IN4742A	-	. 20	. 20		\$. 786	788	151
IN5229B	7	.15	.15		[786	786	911
2N2222A	1	.40	.40			316	316	126
SEM 30	2	.80	1.60		10	.155	.310	248
TRSTR, SI	7	. 15	.15		و	.316	.316	.047
DIODE, SI	7	. 35	07.		02	.155	.310	. 109
RESISTOR FC.	11	.03	.33		55	.10	141	760
RESISTOR MF	~	.37	.74		10	.042	780	047
ω1L	4	.12	. 48		24	690.	276	0.1
CAP AL.	9	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	. 291	2.910	.378
TRANSFORMER	7	2.44	2.44		40	8.998	8.998	21.955
POTENTIONETER	7	.84	1.68		30	.644	1.328	1.116
PC BOARD	٦	2.00	2.00	818	25		٠,-	41
MISC. HDW.	roz	. 50	.50		50			
SHT MTL.	TOT	. 50	.50	167	50		1	
TOTALS		<u>-</u> -	22.41	985	425 × 1.5 (678)		29.57	35.306 (5.38)
				•		_		

THE NAME OR	QTY	TIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE
		ig 3	833	HANUFACTURING	ASSEMBLY	RATE	RATE	Table Time A
7400	1	.24	.24		8	.120	.120	620.
7402	3	.24	.72		24	.120	. 360	.086
7404	9	.26	1.56		48	.180	1.080	.281
7408	2	36	.52		16	120	.240	.062
7432	4	36	. 26		60	120	.120	110
1479	7	F	.62		91	.115	1.430	.443
74126	1	*	-44		80	.715	315.	. 315
74161	3	.54	1.62		24	311,	2.145	1.158
74166	9	.93	5.58		48	.715	4.290	3, 990
741521	1	-24	.24		8	090	,060	•10.
NC 556	2	.85	1.70		10	.715	1,430	1.216
[8]	4	10.00	40.00		80	711	1.268	12.680
TSTR NPN	9	.14	.84		36	.316	1.8%	. 265
CM75S29	1	1.29	1.29		8	.115	3115	.922
M174C910	4	2.40	7.40		8	5	7115	5.29
Resistors	Z	.03	2.82		470	.013	1.22	760,
Capacitors	94	17	1.30		50	.629	6.290	.818
Crystal	4	10.00	10,00		15	1,500	1.500	15.000
PC Board	-	5.00	5.00	818	25	J	*	•
Misc. Hdv.	Pot	95,	-50		50	•	_	•
LSI Socket	*	1.25	5.00		80	-	Þ	•
TOTALS			87.65	818	192888) 2		25.596	42.637 (7.50)

SYSTEM Baseline DABS Transponder

SUR-ASSEMBLY Chassis & Enclosure

ITEM NAME OR	QTV	UNIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL FAILUSE	QTY × FAIL. RATE
CATEGORY		2005 1	T.OS.T	HANUFAC'TURING	ASSEMBLY	RATE	RATE	
PRONT PANEL	7			74	22		ŧ	•
CHASSIS	1			184	44	•	,	•
TOP COVER	1	15.00	15.00	41	22		•	•
HOUNT	1			184	20	•	,	•
BOTTOM COVER	1			48	20	-	,	•
PANEL PC BOARD	1	5.00	5.00	818	100	1	,	
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.0009
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	6.650
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIONETER	1	.35	.35		15	.664	664	.232
PUSH BT. SWITCH	ι	05.	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	ι	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	R 2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	•	_	1
SH'T METAL	LOT	3.00	3.00		200	-	1	ſ
RF CONNECTOR	1	1.23	1.23		15		1	ı
FLEX CABLING	LOT	5.00	5.00		500	-	1	•
CODE, SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC COMNECTOR	4	1.26	5.04		60			
TOTALS			89.54	1349	1793		429.527	6185.267

The second of th

CATEGORY	22	T145	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OT * FAIL. MYE
				MANUFACTURING	ASSEMBLY	FAILURE	FAILURE RATE	x UNIT CUST
IP ARD	1				50			
Hod/Demod	1				50			
PWT Supply	4				150			
Processor Boar	-				25			
Cavity	4				100			
Preselector	1				50			
LP Filter	4				50			
Front Panel	1				25			
Covers	lot				25			
Alignment	•				200			
Burn-In	•				8			
Test	,				1000			
	j							
TITALS					2525			

APPENDIX A-15

DABS WITH COMM A AND B AND ATARS

(LSI Version)

H	
NCL.	
COMP.	
4	
Ľ	
SEMB	
- AS	
3	

TTFH NAME OR	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY × FAIL. RATE
		1000	200	HANUFACTURING	ASSEMBLY	PATE	RATE	res limix
7416	~	88	88.		80	. 786	. 786	.692
74121	1	. 31	.31		9	. 786	.786	244
TY277	1	.36	. 36		\$.715	317.	.257
IN4151	3	.30	.90		15	, 150	.450	.135
IM743	1	.20	.20		5	.786	. 786	.157
2N5086	3	11.	11.		18	2.124	6.372	. 361
MPE6515	1	.43	43		9	. 316	. 316	981.
MPSH10	1	.33	.33		9	.316	. 316	, 104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		9	. 316	. 316	.130
DIODE, SI	4	. 32	.32		5	.155	,155	050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	. 36	.72		10	. 160	. 320	3115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	-	.41	1.23		15	.550	1.650	979.
RESISTOR A/C	64	:03	1.92		320	.013	.832	.025
CHOKE	9	. 36	2.16		36	2.120	12.720	4.579
COIL	s	.12	.60		30 .	690.	. 345	. 041
COIL RF	7	.28	95.		12	.475	.950	. 266
CRYSTAL	7	9.00	8.00		15	1,500	1,500	12.000
FILTER	7	.28	.28		9	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

ITEM NAME OR	OTY	TIND	TOTAL	LAROR HOURS PER 1000 UNITS	1000 UNITS	TENO	1077L	OTY X FAIL. RATE
CATEGORY	l	TSO:	COST	HANUFACTURING	ASSEMBLY	FAILURE RATE	FAILURE RATE	* UNIT CUST
TRANSF	و	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	ā	-	•
MISC. Hdw.	101	,50	.50		50	ļ	ı	ι
SHT. MTC.	101	1.50	1.50	167	50	-	ı	
TOTALS			44.25	985	987 × 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

	}
¥OĐ.	
PPH	
DPSK DEMOD. / PPM MOD.	
DPSK	
SCHOOL ASSESSED.	

ITEM NAME OR	OTY	1.131	TYYEA	TARING BOUR GIVE GOVERN				
CATECORY		COST	COST	Nal salon none	2000 0001	FAILURE	TOTAL	OTY x FAIL. RATE x that cast
				NANUFACTURING	ASSEMBLY	PATE	RATE	
7404	7	. 26	.26		0	316		
7408	-	.26	36			: 173	417	.186
			2		2	.120	.120	.031
7478	-	15.	.31		8	.715	.715	.222
74121	+	F	.31		80	715	316	
74132	7	.64	.64		60	120		
67121	~	1,24	1.24		9	715	715	77.0
2N3646	7	69	.68		9	316	116	788.
MPSA56	2	.17	.34		12	316		
CAP DISC.	15	.13	1,95		75	291	3,65	107
CAP VAR.	-	.23	.23		15	8.599	8, 599	1 978
RESISTOR FC	7	.03	.21		35	.013	160	7.00
PHASE LOCK LOOP	4	5.00	5.00		50	.715	215	353 6
POTEWTIONETER	7	.42	.42		15	.664	664	37.0
PC Board	-	2.00	21	818	25			
MISC. HDW	LOT	.50	.50		50			
TOTALS			14.35	818	3(494) 1.5		18.482	82.383)

SHEET 4 OF 8

SYSTEM DABS TRANSPONDER

SUB-ASSPABLY POWER SUPPLY

ITEH NAME OR CATEGORY	orr	TIMO	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY * FALL, PATE
		3	3	HANDFACTURING	ASSEMBLY	FAILURE	FAILURE	* UNIT CUST
NJE200	2	.57	1.14		16	1.970	3 940	
MJE1100	1	1.33	1.33					7.740
MJE2801	1	1.33	11.11			1.970	1.970	2.620
IN4733A	-	۶	96		20	1.970	1.970	2.620
		3			5	. 786	. 786	.157
1N4735A	-	.20	. 20		\$. 786	786	16.3
IN4742A	-	.20	. 20		5	.786	786	763
IN5229B	1	.15	.15		\$	786	3 2	751
2N2222A	-	.40	.40		9	367	. /80	.118
SEM 30	2	.80	1.60		01	155	917	126
TRSTR, SI	1	51.	.15		9	27.6	OIF:	.248
DIODE, SI	2	. 35	02.		10	156	-316	.047
RESISTOR PC.	11	.03	33				. 310	. 109
RESISTOR MF	7	.37	7,4			100	143	700
w1r	4	12	4.9		10	.042	1084	.047
CAP AL.					24	690.	. 276	160,
24 842	•	-84	5.04		36	.629	3.774	3.170
3	07	:13	1.30		50	. 291	2.910	378
TRANSFORMER	-	2.44	2.44		40	8.998	8 998	31 066
POTENTIONETER	2	.84	1.68		30	.644	1.128	4423
PC BOARD	~	2.00	2.00	818	25			1:116
MISC. HDW.	ror	. 50	.50		50			
SHT MTL.	LUT	. 50	.50	167	50			
TOTALS			22.41	985	425 × 1.5 (678)		29.57	35.306

SYSTEM DABS with Comm A: B and ATARS

SIED-ASSEMBLY MAIN	IN PC BOARD	q						
ITEM NAME OR	QTY	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
united the		iso	T P	HANUFACTURING	ASSEMBLY	FAILURE	RATE	Legge K
7400	1	.24	.24		8	.120	.120	.029
7402	4	-24	- 12		24	.120	360	.086
7404	9	3.26	1.56		48	. 180	1.080	.281
7408	7	.26	.52		16	. 120	,240	.062
7417	1	.21	1.89		56	120	.840	.227
7472	-	78	26		8	.120	120	160.
7478	2	TF.	.93		16	. 715	1.430	\$99.
74126	-	-44			œ	3115	3.115	315
74161	1	.54	1.62		24	.715	2.145	1.158
74164	9	.93	5.58		46	.715	4, 290	3.990
74166	9	.93	5.58		48	3115	4.290	3.990
74.631	-	.24	.24		æ	090	.060	0.014
SW7445 LB	7	8.	2.65		24	.715	2.145	2.038
SN7447A	8	.86	6,88		19	3115	5.720	4.920
NC556	•	.85	2.55		15	.715	2.145	1.823
0475529	1	1.29	1.29		80	311.	. 715	.922
140910	1	7.40	7.40		8	.715	.715	5,290
TSTR MPH	9	41.	.84		36	. 316	1.896	.265
181	5	10.00	50.00		100	.317	1.585	15.850
TUTALS								

The same and the s

).

FSTEM DABS with Comm A: B and ATARS

5 7 7	TIMO		LABOR HOURS PER 1000 UNITS	1000 UNITS	CALLINE	TOTAL	A UNIT COST
		1 200	PANUFACTURING	ASSEMBLY	RATE.	RATE	
	2.07	7 24.84		99	311.	8,580	17.761
	1	├-		10	211.	1.43	2.503
-	-	-		80	311.	11.444	3.318
	\vdash	_		40	.115	5.720	1.716
1	<u> </u>	1		1152	610.	1.872	0.056
The state of the s	-	-		160	. 291	5.820	757
	15	╀		15	1.500	1.500	15.00
_	-	├	818	25	-	1	•
-	1	 		50	•	•	•
+	-	"		190	•	1,	•
151 MONTH 151	+	-					
	-						
	-						
	-						
	-						
	-						
	<u> </u>						
rorals	-	155.44	818	2259 x 2 (4518)		66.977	(5.58)

YSTEM DABS Transponder

Chassis & Enclosure
3
2
•
2
u,
2
7
E

I THEM MAND OR	1							
CATEGORY	15	CNIT	TOTAL	IABOR HOURS PER 1000 UNITS	1000 UNITS	GNIT	TOTAL	OTY × FAIL. RATE
			3	HANUFACTURING	ASSENBLY	RATE	FALLURE	x UNIT COST
PROMT PANEL	-			74	22		,	•
CHASSIS	1			164	41		•	
TOP COVER	1	15.00	15.00	14	22	٠		
HOUNT	-			184	20			
BOTTON COVER	1			48	20	,		-
CAVIST	1	30.00	30.00		225	200.000	200,000	6000.000
PRESELECTOR	-	7.50	7.50		50	1.10	1.160	8.850
L.P. FILTER	1	3.00	3,00		25	11.844	11.844	35.532
POTENTIONETER	1	. 35	.35		15	.664	.644	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4,415	7.417
LMP	4	.62	2.48		9	25.856	103.424	64.123
24PIN CONNECTOR	2	.95	1.90		50	1.128	2,256	2.143
MISC HDW.	TOT	2.00	2.00		100	•		
SH'T. HETAL	101	3.00	3.00		200	,	-	
BP COMMECTOR	7	1.23	1.23		15	•		,
FLEX CABLING	TO3	5.00	5,00		500	•	•	
THURBINEEL	4	1.00	4,00		100	2.395	9.580	9.580
PC COMNECTOR	*	1.26	5.04		09			
PANEL PC BOARD	1	2,00	2.00	818				
TOTALS			84.68	1349	1653		151,959	6137.175

SHEET 8 OF 8

SIM-ASSIMBLY ASSY, & Test

SYSTEM

ITEM WANE OR CATERORY	ŶŦŶ	\$10K)	TOTAL	LANOR HOURS FER 1000 UNITS	1000 UNITS	T. 40	TOTAL	QTY × PALL. RATE.
		or,	9)	PANUFACTURIES	ASSEMBLY	FATCURE	FA1LURE RATE	x UNIT COST
IF Amp	-				05			
Hod/Demod	~				0.5			
PWr Supply	1				150			
Processor Board	4 1				35			
Cavity	4				901			
Preselector	1				05			
LP Filter	1				50			
Front Panel	1				300			
Covers	Lot				25			
Aliquent	*				£200			
Burn-In	•				203			
Test	•							
					TSIM!			
	1							
THALS					3200			

APPENDIX A-16

DABS WITH COMM A AND B, ATARS AND BCAS INTERFACE
(LSI Version)

SYSTEM DABS Transponder

SUB-ASSEMILY __IE ABOLITIEE ____

TIEN NAME OR	DIV.	TIM	TOTAL.	LAIWR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE
THOUSE IN		T S S	CUST	HAWUFACTURING	ASSEMBLY	RATE	RATE	Tiery Elect x
7416	1	.88	.88		8	. 786	. 786	.692
74121	1	.31	.31		8	.786	. 786	.244
TV277	1	,36	. 36		2	315	.715	.257
IMAISI	3	.30	06.		15	. 150	.450	.135
IM743	1	.20	.20		S	.786	. 786	.157
2N5086	-	11.	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		9	.316	. 316	981.
MPSH10	1	.33	. 33		9	.316	, 316	. 104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	4	38	38		S	315.	.75	2.72
TSTR. SI	1	.41	.41		9	.316	. 316	.130
DIODE. SI	1	.32	.32		5	.155	. 155	050.
CAP. STO.	4	.93	3.72		18	.629	2,516	2.340
CAP. CER.	7	. 36	п.		10	.160	. 320	3115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP, T	1	.41	1.23		15	. 550	1,650	.676
RESISTOR A/C	9	.03	1.92		320	.013	.832	. 025
CHOICE	9	. 36	2.16		36	2.120	12.720	4.579
7100	8	21.	.60		30	690.	. 345	. 041
COT1. RF	2	. 28	.56		12	.475	. 950	. 266
CRISTAL	1	8.00	8.00		15	1.500	1,500	12.000
FILTER		. 28	. 28		9	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SHEET 2

SUB-ASSPRIN __IP Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OTY * FAIL. RATE
		8	833	HANUFACTURING	ASSEMBLY	FAILURE	FATUURE	x UNIT COST
TRANSP	9	. 38	2.28		40	2.309	11.854	\$ 366
PC Board	-	4 .00	4.00	818	25	,	,	
HISC. Hdw.	101	,50	.50		50		,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
SHT, MTC.	101	1.50	1,50	167	50	-		
THAIS			44.25	985	987 × 1.5 (1481)		70.342	35.445

SHEET 3 OF 8

SYSTEM DARS Transponder

SUB-ASSEMBLY DPSK DENOD. / PPH MOD.

ITEM NAME OR CATEGORY	QTY	TIND	TUTAL.	LAROR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOFAL	QTY x F/: L. RATE
				NANUFACTUR ING	ASSEMBLY	FAILURE	FAILURE RATE	× UNIT COST
7404	~	92.	.26		æ	316		
7408	-	. 26	. 26		8	.120	120	186
7478	7	.31	.31		8	.715	715	333
74121	4	181	18		8	715	316	277
74132	1	.64	.64		8	120	130	233
67121	7	1.24	1.24		9	.715	715	7/00
2N3646	7	89.	89.		9	. 316	.316	316
MPSA56	7	-11	.34		12	116	613	
CAP DISC.	15	.13	1.95		75	.291	4.365	295
CAP VAR.	-	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOO	4	5.00	5.00		\$0	317.	.715	3.575
POTE!!TIONETER	1	.42	.42		15	.664	.664	972.
PC Board	-	2.00	2.00	818	25			
MISC. HOW	LOT	.50	.50		20			
	4							
TOTALS			14.35	818	328.4, 1.5		18.482	82.83)

SYSTEM DADS TRANSPONDER

SIM-ASSIMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	TIMIT	TOTAL.	LANDR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY & FAIL, EATE
			3	HAMUFACTURERG	ASSEMBLY	FATLURE	FAILURE	LSC LIM x
MJE200	~	.57	1.14		16	1.970	3.940	2 346
NJE1100	~	1.33	1,33		a	8		
NJE2801	1	1.33	1.33		•	930	1, 636	2.620
IN4733A	1	. 20	.20		5	786	786	2.620
IN4735A	1	. 20	8					(CI)
IM4742A	1	2	.20		2	487	786	157
IN5229B	-	.15	st.			26/	. 786	157
2N2222A	-	9.	\$.			. 786	. 786	.118
SEM 30	7	8	3.1		9 9	316	316.	126
TRSTR, SI	1	. 15	.15		9	311	216	.248
DIOOE, SI	2	35	07.		10	155	210	.047
RESISTOR PC.	17	.03	εε.					. 109
RESISTOR MF	2	. 37	.74		9	2013	143	004
COIL	4	21.	.48			.042	. 084	
CAP AL.	٥	.84	5.04		5	.069	.276	.031
CAP DC	01	1:1	7.30		3	679.	3.774	3.170
TRANSFORMER	-	2.44			8	. 291	2.910	.378
POTENTIONETER	1		5.5		90	8, 998	8, 998	21.955
on and one	•	6.	1.68		30	.644	1.328	1.116
ar Bowle	-	2.8	2.00	818	25			;
ALSC. HOW.	53	.50	.50		50		:	
SAT MEL.	103	8	.50	167	50			
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)
					_	_		

SYSTEM DABS with Comm A: B and ATARS SIR-ASSEMBLY MAIN PC ROARD

ITEM NAME OR CATEMORY	ξĘ.	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTV × FAIL. P.
		2		HAHUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
7400	~	.24	. 24		8	.120	.120	970
7402	7	25.	n.		24	0,1	360	200
7404	9	. 26	1.56		48	001	2000	don
7408	2	. 26	.52		21	2	1.080	107
7417	,	"	00		21	170	.240	.062
7412	-	*	75		95	120	.840	.227
7478	2	7	6		2	.120	.120	.031
74126	7	. 44	44		01	517	1.430	. 665
74161	~	.54	1.62		24	3.5	en .	\$11.
74164	٥	.93	5.58		48	715	4.290	RCT . T
74166	٥	.93	5.58		48	.715	4.290	3.990
741821	4	-24	-29		8	.060	090	0.034
SN7445 LB	7	\$6.	2.85		24	.715	2.145	2.038
SN7447A	8	98	6.68		64	3115	5.720	4.920
NC556	3	.85	2.55		15	. 715	2.145	1.823
DM75529	1	1.29	1.29		8	. 715	.715	. 922
140910	7	7.40	7,40		8	.715	.715	5,290
TSTR NPN	9	22.	.84		36	. 316	1.8%	.265
151	5	10.00	50.00		100	.317	1.585	15.850
	1							
TOTALS								
•				_				

SYSTEM DABS With Comm A: B and ATARS

SUD-ASSEMBLY MAIN	n PC Board		•					
ITEM NAME OR	OTY	TINO	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE × UNIT COST
CATECORY		1300	1.900	PANUFACTURING	ASSEMBLY	RATE	RATE	
LED DLY6661	12	2.07	24.84		9	.715	8.580	17.761
2655-QMIN 031	2	1.75	3.50		10	217.	1.43	2.503
ו-9נאסט עסו	16	,29	4.64		08	.715	11.444	3.318
1 ED COV18-1	8	30	2.40		40	.715	5.720	1.716
Section 2	144	60	4.32		1152	.013	1.872	0.056
CADACITORS	ç	11	2.60		160	.291	5.820	7.57
CRYSTAL	-	10.00	10,00		15	1.500	1.500	15.00
br Board	-	5.00	5.00	918	25			
Misc. Hdw	lot	.50	.50		50	•	,	-
191 Cockets	5	1.25	6.25		001	ı	1.	
TOTALS			155.44	818	2259 x 2 (4518)		66.977	83.067 (5.58)

SHEET 7 OF 8

SYSTEM DABS Transponder

SUb-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	ALIŌ	UNIT	TOTAL	LABOR HOURS FER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV × FAIL. RATE
		T CONT	6	HANUFACTURING	ASSEMBLY	FATLURE RATE	FAILURE	x UNIT COST
FRONT PANEL	-			74	22			-
CHASSIS	7			184	44	1		,
TOP COVER		15.00	15.00	41	22	,		,
MOUNT	-			184	20		,	
BOTTOM COVER	1			48	20	-		
CAVITY	1	30.00	30.00		225	200.000	200.000	6000 000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. PILTER	1	3.00	3,00		25	11.644	11.844	35.512
POTENTIONETER	4	.35	, 35		15	.664	.644	232
PUSH BT. SWITCH	~	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	7	1.68	1,68		100	4.415	4,415	7.417
LAMP	4	.62	2,48		09	25.856	103.424	64.123
24PIN CONNECTOR	7	.95	1.90		50	1.128	2,256	2.143
MISC HDW.	101	2.00	2.00		100			,
SH'T. METAL	IOT	3,00	3.00		200	,		
RF COMMECTOR	4	1.23	1,23		51	1		
ELEX CABLING	101	5.00	5,00		500	,		ı
THUMBMIEEL	4	8.1	4,00		100	2.395	9,580	9.580
PC CONNECTOR	4	1.26	5.04		09		,	
PANEL PC BOARD	-	2.00	2.00	818				
	1							
TOTALS			84.68	1349	1653		351,959	6137.175 (78,47)

SUR ASSEMBLY ASSY. & Test

ITEM NAME OR	QTY	TINO	TOT'AL.	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. HATE
		i ego	T (S) T	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT COST
IF Amp	1				50			
Mod/Demod	7				05			
Pwr Supply	4				150			
Processor Board	1				25			
Cavity	1				901			
Preselector	4				05			
LP Filter	1				50			
Front Panel	1				000			
Covers	Lot				25			
Alignment					2003			
Burn-In	•				200			
Test	•				007			
	1							
TOTALS					3200			

APPENDIX A-17

DABS WITH COMM A, B, AND C
(LSI Version)

SHEET I OF 8

SYSTEM DABS Transponder
SUB-ASSEMBLY IF AMPLICIAL

CATEGORY	Ē	TIND	TOTAL.	IABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RA
			1	MANUFACTURING	ASSEMBLY	FAILUNE	FAILURE	x UNIT COST
7416	7	.88	88		8	.786	786	603
74121	-	. 31	. 31		8	786	706	260.
LN277	-	.36	. 36		3	7115	316	167
IM151	3	, 30	8.		15	1.0	450	163:
IN4741	-	.20	.20		5	786	302	55.
2N5086	6	111	11.		81	2.124	6.372	.361
MPS6515	7	.43	.43		9	. 316	.316	.136
MPSHIO	7	.33	.33		9	.316	. 316	104
SPS6797	æ	. 78	6.24		48	. 715	5.720	4.462
5082-2835	4	38	38		5	.715	.75	2.72
15TR. 81	4	.41	.41		9	, 316	.316	130
DIODE, SI	4	.32	.32		5	.155	,155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	. 36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.65		225	. 291	13.095	1.702
CAP. T		14.	1.23		15	. 550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	9	.36	2.16		36	2,120	12.720	4.579
COIL	2	.12	.60		30	690.	.345	.041
COIL RE	2	82.	.56		12	.475	.950	.266
CRYSTAL	7	9.00	9.00		15	1.500	1,500	12.000
FILTER	-	.28	.28		9	5.127	5.127	1.436
TOTALS								

melifier (Cont'd)
IF
SUN-ASSEMBLY

							•	
ITTM NAME OR	QTY	TIM	TOTAL	LAROR HOURS PER 1000 UNITS	1000 UNITS	UNIT	107AL	QTY × FAIL. RATE
CALEADAT		CUET	1833	HAMBACTURING	ASSEMBLY	FAILURE RATE	FALLURE	A UNIT CAST
TRANSF	9	. 38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	918	25	-		•
MISC. Hdw.	101	,50	.50		50	-		
SHT. MTC.	101	1,50	1,50	167	50	•	,	-
TOTALS			44.25	\$86	987 x 1.5 (1481)		70.342	35.445

STEM DABS Transponder

100	
PPM	
DEMOD.	
DPSK	
- ASSEMBLY	
3	

CATEGORY		11NO	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	CALLE	TOTAL	VIT X FAIL. RATE
		3		HANDFACTURING	ASSEMBLY	RATE	PATE	
7404	1	. 26	92.		8	.735	215	186
	1	. 26	. 26		8	.120	.120	.031
7478	1	.31	. 31		8	. 715	. 715	. 222
74121	4	16.	18.		8	215	715	222
74132		.64	.64		6	.120	120	7.00.
	7	1.24	1.24		9	.715	.715	.887
2N3646	1	89.	.68		9	.316	316.	.215
MPSA56	2	.17	34		12	.316	632	107
CAP DISC.	5t	,13	1,95		75	.291	4.365	.567
CAP VAR.	-	.23	.23		15	8.599	8,599	1.978
RESISTOR FC	,	.03	.21		35	.013	.091	.003
PHASE LOCK LOO	4	5.00	5.00		50	5115.	.715	3,575
POTENTIONETER	-	.42	.42		51	.664	.664	672.
PC Board	~	2.00	2.00	818	25	,		•
MISC. HDW	LOT	05.	.50		50	3	•	•
TOTALS			14.35	818	323,34,1.5		16.462	(2.383)

SHEET 4 OF 8

SYSTEM DAME TRANSPONDER

SUB-ASSEMBLY PONTR SUPPLY

ITEM NAME OR CATECORY	ATQ.	TIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIME	TOTAL	QTY × FAIL. RATE
			5	HANUFACTURING	ASSEMBLY	FATUNE RATE	FAILURE	x UNIT COST
MJE200	2	.57	1.14		16	1.970	3 040	25.6
MJE1100	1	1.33	1,33		a			047.7
NJE2801	~	1.33	1.33		9	0750	1.970	2.620
IN4733A	7	.20	.20			1.970	1.970	2.620
IN4735A	7	۶	5			8	8	.157
IN4742A	-	8	2		2	.786	786	157
IN5229B	-	3.	2		0	. 786	.786	.157
2N2222A	-	9	8		8	. 786	.786	911,
SEM 30	- -	3			9	. 316	.316	126
40040	• -	8	8.		10	.155	. 310	.248
insin, st	٠,	. 15	.15		9	. 316	.316	.047
DIODE, SI	2	Sť.	۰۲۵		10	. 155	.310	109
RESISTOR FC.	7	.03	.33		55	613		
RESISTOR MP	2	.37	.74		ot		100	900
COIL	•	.12	.48		24	260	-084	270
CAP AL.	9	-84	5.04		, s	500:	.276	.031
CAP DC	01	ei.	1.30			679.	3.774	3.170
TRANSPORMER	-	2.44	2.44		2	167:	2.910	.378
POTENTIONETER	2		1.68		40	8, 998	8.998	21.955
PC BOARD	-	2 00	8	0.0	26	. 644	1. 328	1,116
MISC. HIM.	٤	5	3	010	25			
	3) oc:	06.		50	-		-
off Fil.	ş	.50	.50	167	50		1 1 6	1
TOTALS			22.41	982	425 × 1.5 (678)		29.57	35.306 (5.38)

SHEET 5 OF 8

SYSTEM DABS with Comm A&B and ELM UPLINK

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR) La	TIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY × FAIL. RATE
CATEGORY		Tech	CUST	HANUFACTURING	ASSEMBLY	RATE	RATE	Table Time x
7400	1	.24	.24		8	.120	.120	620.
7402	3	72	27.		24	.120	. 360	980.
7404	9	,26	1.56		48	. 180	1.080	.281
7408	2	.26	.52		16	.120	.240	,062
7432	3	.26	. 26		æ	.120	120	.031
2478	7	R	.62		भ्र	2115	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	9	.93	5.58		48	3115	4.290	3.990
741.521	4	24	.24		α	.060	090	•10
HC 556	7	-85	1.70		.00	.715	1.430	1.216
74126	1	.44	44.		8	.715	.715	.315
DM75529	7	1.29	1.29		8	.715	.715	.922
NE474C910	1	7.40	7.40		89	.715	.715	5,290
74157	1		.72		8	.715	.715	515.
8048	1	7.50	7.50		20	.507	. 507	3.803
HCH4027AC4	1	3.80	3.80		16	.715	. 715	2.717
TOTALS								

HEET 6 OF 8

SYSTEM DABS with Comm A&B and ELM UPLINK

SUB-ASSPERLY MAIN	N PC BOARD		;					
ITTER NAME OR	on.	TIM	TOTAL.	Labor Hours Per 1000 units	1000 UNITS	CATTION	TOTAL	OTY × PAIL, PATE × UNIT COST
CATEGORY		200	C067	HANUFACTURING	ASSEMBLY	RATE	RATE	
181	•	10.00	40.00		90	200	1.268	12.680
TSTR MPN	9	.14	.84		36	.316	1.8%	. 265
RESISTORS	601	,03	3.27		485	.013	1.417	.043
South	20	17	2.50		700	.291	5.820	151
CDYSTAL	~	10.00	20.00		30	1.500	3.000	30,00
COMMECTOR	1	1.60	1.60		25	·	•	1
P. C. BOARD	1	5.00	5.00	818	25	ŧ	ſ	•
Misc. Biby	lot	1.50	1.50		50	•	•	
1ST Cocket	•	1.25	00.4		980			•
							~	
TUTALS			112.42	818	1164 x 2 (2328)		28.758	(10.11)
		•						

SYSTEM BASELING DABS Transponder

SUG-ASSEMBLY Chassis & Enclosure

ITEM NAME OR	710	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY x FAIL. RATE
CALBAORE		T.S.	ism	HANUFACTURING	ASSEMBLY	RATE	RATE	
FRONT PANEL	1			74	22	1	•	1
CHASSIS	1			184	44		•	•
TOP COVER	1	15.00	15.00	41	22	1	•	•
HOUNT	1			184	20	1	1	•
BOTTON COVER	1			48	20		•	-
PANEL PC BOARD	1	5.00	5.00	818	100	•	•	ŝ
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	9.850
L.P. PILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIONETER	1	. 35	. 35		15	.664	664	282,
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.5%	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN COMMECTOR	2	.95	1.90		50	1.128	2.256	2,143
MISC. HDW.	101	2.00	2.00		100		•	•
SH'T METAL	101	3.00	3.00		200	•	_	1
RF COMNECTOR	1	1.23	1.23		15	_	•	
PLEX CABLING	LOT	5.00	5.00		500	•	,	٠
CODE SMITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	•	1.26	5.04		90			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)
					-	_	_	

0 r 8	
œ	
SHEET	

SYSTEM DABS TRANSPONDER
GUB-ASSEMBLY ASSY, 6 Test

ITEM NAME OR	QTY	TIND	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TIMO	TOTAL	OTV * FAIL. RA
		1893	rego.	HANUFACTURING	ASSENBLY	RATE	FATEURE	X UNIT COST
IF AND	1				90			
Mod/Demod	1				20			
Per Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	7				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	JOE				25			
Alignment	•				\$00			
Burn-In	-				200			
Test	•				2000			
	-							
TOTALS					. 3525			

APPENDIX A-18

DABS WITH COMM A, B, AND C AND ATARS
(LSI Version)

SUB-ASSEMBLY IR AMULICIES

ITEM NAME OR CATBONEY	QTY	TIMI	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	טאנד	TOTAL	QTY × FAIL. RATE
			Q.	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT CUST
7416	4	88	88.		8	. 786	786	603
74121	1	.31	. 31		8	. 786	. 786	244
IN277	-	. 36	. 36		5	.715	311.	.257
IM151	7	.30	.90		15	. 150	.450	.135
IN4743	1	.20	.20		5	. 786	. 786	.157
2N5086	7	-112	17.		18	2.124	6.372	. 361
HPS6515	4	:43	.43		9	.316	.316	.136
MPSH10	~	.33	.33		9	. 316	.316	. 104
SPS6797	8	.78	6.24		48	311.	5.720	4.462
5082-2835	4	.38	98		5	.715	57.	2.72
TSTR. SI	-	14.	.41		9	. 316	.316	130
DIODE, SI	-	.32	.32		5	. 155	.155	050
CAP. STO.	4	.93	3.72		18	.629	2.516	2 340
CAP. CER.	7	. 36	.72		10	.160	.320	115
CAP. DISC.	45	.13	5.85		225	. 291	13.095	1 302
CAP. T	7	.41	1.23		15	.550	1.650	6.76
RESISTOR AC	64	.03	1.92		320	.013	.832	.025
CHOKE	9	.36	2,16		36	2.120	12.720	4.579
COIL	2	.12	.60		30	690.	.345	.041
COIL RF	2	.28	.56		12	.475	. 950	.266
CRYSTAL	+	8.00	8.00		15	1.500	1.500	12 000
FILTER	1	.28	.28		9	5 127	6 137	
'KYTALS								gr w
_	_	-			_			

SHEET 2 OF

SYSTEM DABS Transponder
SUR-ASSDERY IF MEDIIIER (Cont'd)

ITEM NAME OR	QTV	UNIT	TOTAL.	LAUGH HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY × FAIL. RATE
			CUST	PIANJEACTURING	ASSEMBLY	FAI LURE RATE	FAILURE	x UNIT CRET
TRANSF	9	. 38	2.28		40	2,309	13.854	5 266
PC Board	4	4.00	4.00	818	25		,	
MISC. Hdw.	LOT	.50	.50		50			
SHT. MTC.	IOT	1,50	1.50	167	50	,		
	4							
TOTALS			44.25	28%	967 × 1.5 (1461)		70.342	35.445

SHEET 3 OF 8

SYSTEM DABS Transponder

SUB-ASSEMBLY DPSK DEMOD./PPN MOD.

ITEM NAME OR	ÛŢŸ	TIMO	TOTAL	IABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY × FAIL. RATE
CATEGORY		cos#	COST	PIANUFACTURING	ASSEMBLY	FA1LURE RATE	FAILURE RATE	× UNIT COST
7404	1	. 26	. 26			.715	715	.186
7408	1	.26	. 26		8	.120	.120	.031
7478	1	.31	ıı.		8	.715	315	.222
74121	4	16	111		В	.715	215	233
74132	1	.64	.64		8	.120	120	720.
67121	1	1.24	1.24		9	.715	.715	.887
2N3646	1	89.	.68		9	. 316	.316	.215
MPSA56	2	.17	.34		12	316	.612	107
CAP DISC.	15	.13	1.95		75	.291	4.365	. 567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOOP	4	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	972.
PC Board	1	2.00	2.00	818	25			
MISC. HDW	LOT	.50	.50		50	ı		-
TOTALS			14.35	818	329, 1.5		18.482	(2.33)

SHEET 4 OF 8

SYSTEM DABS TRANSPONDER

SIB-ASSEMBLY POWER SUPPLY

THY NAME OR CATEGORY	QTY	INIT	TOTAL.	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTY x FAIL. RATE
		<u> </u>		MANUFACTURITIES	ASSEMBLY	FATLURE	FAILURE	* UNIT CIST
HJE200	2	.57	1.14		1		2	
MJE1100	-	=			2	1.970	3.940	2.246
MJE2801			4.23		8	1.970	1.970	2.620
	-	5	1.33		8	1.970	1.970	2 620
184/33A	7	. 20	20		5	. 786	.786	15.7
IN4735A	7	. 20	02.					
IN4742A	-	. 20	. 20		,	49/	.786	152
IN5229B	1	.15	.15			. 786	. 786	. 157
2N2222A	7	-40	40		c	. 786	.786	.118
SEM 30	~	8	99		9	. 316	.316	126
TRSTR, SI	-	3.	3 :		10	.155	. 310	. 248
blobe, sr	.].	2	cr:		9	.316	916.	.047
	•	ę.	. 70		10	.155	. 310	109
RESISTOR PC.	7	.03	ι,		37			
RESISTOR MF	7	.37	٠7.				143	700
ω1r	•	.12	48		10	.042	1084	.047
CNP AL.	9	9.	5.04		24	.069	.276	160.
CAP DC	92	13			35	.629	3.774	3.170
TRANSFORMER	-				50	. 291	2.910	. 378
POTENTIONETER			2.44		40	8.953	8.998	21.955
Pr Boass		*0.	1.68		30	.644	1.328	1.116
Mier are		2.00	2.00	818	25	-		
near. non.	, COL	. 50	.50		20			
SHT MTL.	101	95.	. 50	167	50			
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306
-	-	_	_					(5.38)

SYSTEM DARS with Comm AtB, ATARS, and ELM UPLINK

SUB-ASSEMBLY Nat	Main PC Board	9	-					
TIEN NAME OR	QTY	1180	TOTAL	CABOR HOURS PER 1000 UNITS	1000 UNITS	TENO	TOTAL	OTV × FAIL. RATE
CATEGORY		1800	T COST	HANUFACTURING	ASSEMBLY	PATE	MATE	
7400	1	.24	.24		9	.120	.120	. 029
1402	1	24	.72		24	120	360	980
7404	9	.26	1.56		48	.180	1.080	. 281
7408	2	26	52		16	120	.240	.062
7417	1	.27	1,89		56	.120	.840	.227
7432	-	32'	92'		8	.120	.120	.031
1478	2	17.	.93		16	311.	1.430	.665
74126	-	75.	- 44		B	.715	715	315
74161	-	25	7.62		24	.115	2.145	1.158
74164	9	.83	5.58		48	317.	4,290	1.990
74166	9	.93	5.50		9	.115	4.290	1.990
741521	_	.24	77		e	090	090	0.014
SH74451A	-	8	2.85		77	2115	2.145	2.038
SW7447A	80	8	6.88		79	.715	5.720	4.920
HC556	-	.85	2.55		15	.715	2.145	1.623
DM25629	-	1.29	1.29		B	2115	2115	922
M14C910	4	7.40	7.50		B	2015	3115	5.290
TSTA MPH	9	74	78		36	316	1.8%	.265
181	5	10.00	50.00		100	1317	1,585	15.850
TOTALS	,		الجرادية ع		-			
	_	-	~	-	-	•	-	-

SHEET 6 OF 8

SYSTEM DASS with Comm AGB, ATARS, and ELM UPLINK

SUB-ASSEMBLY MAIN PC BOARD

ITEN NAME OR	prv	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	QTV x PAIL. RATE
		3		HANUFACTURING	ASSEMBLY	FATURE	FAILURE	x UNIT COST
74157	1	22.	27.		8	.715	. 715	515
8048	1	7.50	7.50	•	20	.507	.507	3 803
NO14027AC4	7	3,80	3.80		16	316		Soo is
LED DLY6661	12	2.07	24.84		9	21.6	617.	2.717
LED HLMP-2655	2	1.75	3.50		10	715	6.360	17.761
LED CQV36-3	91	. 29	4.64		Bo	715		506.5
LED CQV38-3	8	0£.	2.40		40	3,5	200	3,318
RESISTORS	159	.03	4.77		22.5	67/	5. 720	1.716
CAPACITORS	æ	EI.	3.90		240	.013	2.067	. 062
CHESTAL	2	5	5			. 291	9.73	1.135
PC Board	-		40.00		30	1.500	3.000	30,000
		3.6	5.00	818	25	,	,	•
Misc. Hrdv.	2	95.	. 50		50		-	
LSI Sockets	5	1.25	6.25		100			
TOTALS			179.21	618	2518 x 2 (5036)		71.519	102.482

SYSTEM DARS Trensponder

9
200
c,
ā
581
8
3
SSE
ş

ITEM MANE OR	orv	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	QTY * FAIL. RATE
CATEGORY		C)67	COST	PIANUL'ACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT (TST
PROOF PAREL	-			7.4	22	•		•
CHASSIS	1			184	44	,	•	1
TOP COVER	1	15.00	15.00	41	22	•	-	•
HOUNT	1			184	20	•	•	•
BOTTON COVER	1			48	20	•	_	•
CAVISTY	1	30.00	30.00		225	200.000	200,000	6000.000
PRESELECTOR	1	7.50	7.50		20	1.18	1.180	9.850
L.P. FILTER	1	3.00	3,00		25	11.844	11.844	35.532
POTENTIONETER	1	.35	.35		15	.664	.644	.232
PUSH BT. SWITCH	٠,	.50	·s.		25	18.596	18.596	9.298
ROTARY SMITCH	-	1.68	1.68		100	4.415	4,415	7.417
LANP	•	3.	2.48		09	25.856	103.424	64.123
24PIN CONNECTOR	2	8.	1.90		50	1.128	2,256	2.143
MISC HDW.	101	2.00	2.00		100	•		
SH'T, METAL	101	3,00	3.00		200	•	,	
BE COMMECTOR	1	1.23	1,23		15	ı	•	
FLEX CABLING	101	8.00	00'5		500	-	1	9
TRUMBUZZI	•	1.00	00'+		100	2.395	9,580	9.580
PC COMMECTOR	•	1.26	¥0°\$		09	•	•	-
PANEL PC BOARD	1	3.00	2.00	618				
TOTALS			84.68	1349	1653		351,959	6137.175

SHEET 8 OF 8

6UB-ASSEMBLY ASSY 6 Test

ITEN MANG OR	Į,	TIMO	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	URIT	TOTAL	OTY × FAIL. RATE
		iem	1	HANUFACTURING	ASSEMBLY	RATE	RATE	Tem K
IF Amp	1				50			
Mod/Demod	1				.50			
Per Supoly	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	7				50			
LP Filter	7				50			
Front Panel	1				200			
Covers	Lot				25			
Aliqueent					500			
Burn-In	1				500			
Tost					2500			
TOTALS					4200			

APPENDIX A-19

DABS WITH COMM A, B, C, AND D
(LSI Version)

SYSTEM DASS Transponder

SUB-ASSEMBLY IF ANDLIFLEE

ITEM NAME OR	מגג	TIM	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	QTV x FAIL. RATE
			1803	MANUFACTURING	ASSEMBLY	PATE	RATE	water cust
7416	1	86.	-88		80	. 786	. 786	.692
74121	1	.31	.31		8	. 786	. 786	.244
18277	1	36	.36		5	311.	.715	752.
191011	3	.30	%		15	.150	.450	361.
194743	4	02	. 20		5	. 786	. 786	.157
2N50 86	3	211	11.		10	2.124	6.372	. 361
MPS6515	4	14.	.43		9	.316	.316	.136
MPSH10	1	.33	. 33		9	. 316	.316	. 104
SPS6797	6	. 78	6.24		48	. 715	5.720	4.462
5062-2835	4	38	38		S	.715	27,	2.72
TSTR. SI	7	.41	.41		9	. 316	.316	.130
DIODE, SI	4	. 32	.32		5	.155	.155	050
CAP. STO.	4	.93	3.72		18	629.	2,516	2,340
CAP. CER.	2	.36	.72		10	. 160	. 320	.115
CAP. DISC.	45	:13	5.85		225	.291	13.095	1.702
CAP. T		.41	1.23		15	.550	1.650	.676
RESISTOR A/C	94	:03	1.92		320	.013	.632	. 025
CHOKE	9	, 36	2.16		36	2.120	12.720	4.579
COIL	\$.12	09.		30	. 069	. 345	190.
COIL RF	2	.28	95.		12	.475	.950	.266
CRYSTAL	1	9,00	8.8		15	1.500	1,500	12.000
PILTER		.20	.28		9	5.127	5.127	1.436
TOTALS	,							
		-	•					

SHEET 2 OF 9

SYSTEM DARS Transponder

SIM-ASSEMBLY IF Amplifier (Cont'd)

ITEM MANE OR	QTY	UNIT	TOTAL	LANOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	JOTAL	QTY × FAIL. RATE
		T.S.T.	COST	HARIUFACTURING	ASSEHBLY	FAILURE RATE	FAILURE	x UNIT COST
TRAKSF	9	.38	2.28		40	2.309	13.654	5 265
PC Board	-	4.00	4.00	818	25			
MISC. Hdv.	101	,50	.50		95			•
SHT. HTC.	101	1.50	1.50	167	50			
	1							
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445

ISTEM DABS Transponder

	l
8	ļ
Š	i
I	ì
¥	ì
₹	l
~	l
ğ	į
00430	ı
3	1
¥	
254	ļ
4	Į
	I
_	
3	
Ŋ	
8	
4	
╽	
3	

ITEM NAME OR	QTY	UNIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	10142	OTY × FAIL. RATE
CALBERTH		COST	CUST	HANDFACTURING	ASSEMBLY	MATE	RATE	I THO Y
7404	1	.26	. 26		8	.715	2115	.186
7408	1	.26	. 26		8	.120	.120	160.
7478	1	,31	ιε.		8	.715	.715	.222
74121	-	16.	TH.		æ	2112	3115	222
74132	1	.64	.64		80	.120	.120	710
67121	1	1.24	1.24		9	.715	.115	.887
2N3646	1	.68	89.		9	.316	316	.215
MPSA56	5:	.17	.34		12	.316	632	107
CAP DISC.	15	:13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8,599	976.1
RESISTOR FC	7	.03	.21		35	.013	160.	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.115	.715	3.575
POTENTIONETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	ŧ		4
MISC. HDW	LOT	.50	.50		50	•		ŧ
	•							
TYTALS			14.35	818	329.4, 1.5		18.482	(2.33)

SYSTEM LABS TRANSPONDER

SIM-ASSIMBLY POMER SUPPLY - COMM A/B, C/D

ITEN NAME OR CATECORY	QTY	UNIT	TOTAL.	LABOR HOURS HEE 1000 UNITS	1000 UNITS	TINO	TOTAL	OTF & FAILLIATE
		3	ŝ	HABUFACTURING	ASSEMBLY	FAILURE	EATLURE RAT"	x UNIT CYST
MJE200	2	.57	1.14		16	1.970	18	,
MJE1100	-	1.33	1.33				***	7. 240
MJE2801	-	-				1.970	028-1	2.620
1047733	•	;	1.33		8	1.970	1.970	2.620
Vecabus	-	02.	.20		•	. 786	. 786	.157
IN4735A	7	. 20	. 20		ی	700		
IN4742A	-	. 20	.20			60/	387	157
IN5229B	-	3			^	. 786	.786	751,
2N2222A			2		5	. 786	. 786	.110
20000	•	2	\$		9	. 316	. 316	126
INJIN, 51	-	. 15	-15		ų	. 316	.316	.047
DIODE, SI	9	. 35	2.10		30	. 155	930	126
RESISTOR FC.	77	.03			, , , , , , , , , , , , , , , , , , ,			
WEISTOR MF	~	. 37	. 74		01	942		900
COIL	•	.12	. 48		2.4	980	190	750
TYA - 1175.11	7	2.51	5.02			600.	9/2	10.
CAP DC	07	[1]	S		00	670.	1.258	3.158
TRANSPORMER	-		*		50	. 291	2.910	. 378
POTENTIONETER		7.33	1.33		40	8, 998	8.998	31.943
Na in the second	,	.#4	1.68		30	.644	1.328	1.116
r. BOARD	-	2.8	2.00	918	25			
MISC. HUM.	103	. 50	.50		50	:		
SIT MIL.	103	.50	.50	167	50			
								-
TOTALS			23.30	985	479 × 115 (719)		27.364	45.251
		-	_					(7.44)

SYSTEM DABS with Comm A&B and BIM UPLINK

SUB-ASSEMBLY H	MAIN PC BOARD	ARD						
ITEM NAME OR	QTY	TINO	TOTAL	LABOR BOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTV × FAIL.
CATEGORY		008T	COST	PRANUFACTURING	ASSEABLY	PATE	RATE	
7400	1	. 24	.24		8	.120	. 120	620.
7402	,	.24	.,,		24	.120	. 360	980.
7404	9	,26	1.56		48	.180	1.080	.281
7408	4	. 26	1.14		32	.120	. 480	.125
7432	-	.26	. 26		8	.120	120	100
7478	2	F	.62		16	2115	1.430	443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	9	.93	5.58		48	3115	4.290	1.990
741,521	4	.29	.24		B	090	090	410
NC 556	2	.85	1.70		10	.715	1.430	1.216
74126	7	7.	.44		8	.715	.715	. 315
DM75529	1	1.29	1.29		æ	. 715	.715	.922
HH74C910	1	7.40	7.40		8	.715	2115	5.290
74157	1	: .72	27.		80	311.	.715	. 515
8039	1	18.65	18.65		20	.507	. 507	9.466
HCH4027AC4	1	3.80	3.80		16	2115	21.5	2.717
TYTALS				· ·				
		الن	_					

SYSTEM DABS with Comm ALB and BLM UPLINK

0

ō

SHEET 6

SUB-ASSEMBLY MAIN PC BOARD

OTY x FAIL. RATE x UNIT COST .265 .046 70.362 (10.87) 12.680 30.000 TOTAL FAILURE RATE 1.268 1.896 1.547 3.000 29.128 ı UNIT FAILURE RATE .317 .316 .291 1.500 1230 x 2 2460 LABOR HOURS PER 1000 UNITS ASSEMBLY 8 535 100 8 25 2 8 HANUFACTURING 818 818 TOTAL 40.00 .84 3.57 2.60 20.00 5.00 1.50 8 124.39 UNIT COST 10.00 7 , 03 .13 10.00 5.8 1.50 1.25 Ę 119 2 Ĕ • 9 ITEM NAME OR CATEGORY CAPACITORS P.C. BOARD LSI Socket PES I STORS Misc. Hob TSTR NPN CRYSTAL 12 TOTALS

SYSTEM DABS TRANSPORDER SUR-ASSEMBLY POWER AMPLIFIER

ITEM NAME OR CATEGORY	QTY	INIT	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	UNIT	TOTAL	OTY X FAIL. RATE:
		O'F	1600	HANUFACTURING	ASSEMBLY	FAILURE	FAILURE	x UNIT CAST
SD1522	1	13.10	13.10		50	17.010	17.010	222. 831
SD1526	1	14.80	14.80		50	17.010	17.010	251.748
SD1530	1	22, 50	22.50		50	35.215	35.215	792.338
SD1538	1	39.60	39.60		50	176.077	176.077	6972.649
CAPS-DISC	14	.13	1.62		70	.291	4.074	015
COILS	8	. 12	96.		40	690.	. 552	990
RESISTORS	S	.03	.15		25	.013	.065	.002
TVA-1319.9	1	2.85	2.85		40	.629	629	1 101
TVA-1318.2	1	2.34	2.34		40	.629	.629	1 479
SUBSTRATE PC	-	15.00	15.00	818	50		,	
RP CONN	1	1.35	1.35		25	,	,	-
ENCLOSURE	1	2.00	2.00	167	44	,	,	
COVER	-	0.50	. 50	42	22	,	,	
MISC. HDW	101	0.50	. 50		50	,	,	
TOTALS			117.47	1027	909		251.261	8243.429

SHEET 8 OF 9

SYSTEM Baseline DARS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEN MAME OR CATEGORY	£	TIND	TOTAL	LABOR HOURS PER 1000 36 FFS	1000 Ukris	UNIT	TOTAL	QTY * FAIL. RATE
				HANUFAC'TURING	ASSEMBLY	FAILURE	FATLURE	x UNIT COST
PRONT PANEL	7			74	22			•
CHASS1S	-			184	44			-
TOP COVER	1	15.00	15.00	41	22			
MOUNT	~			184	20	,		
BOTTON COVER	4			46	20			
PANEL PC BOARD	1	5.00	5.00	818	100		,	
PRESELECTOR	-	7.50	7.50		50	1.18	1.180	8,850
L.P. PILTER	-	3.90	3.00		25	11.844	11.844	35.532
POTENTIONETER	-	35.	35		15	.664	.664	.232
PUSH BT. SWITC	-	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	-	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	R 2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	,		
SH'T METAL	101	3.00	3.00		200	,		,
RF CONNECTOR	1	1.23	1.23		15	,		
FLEX CABLING	LOT	5.00	5.00		500	,		•
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		9			
	1							
	1							
TOTALS			59.54	1349	1568		229.527	185.267

SUB-ASSEMBLY ASSY. 6 Test

SYSTEM

ITEM NAME OR	OTY	TIM5	TOTAL	LABOR HOURS PER 1000 UNITS	1000 UNITS	TINO	TOTAL	OTY × FAIL. RATE
CATEGORI		1983	LUST	MANUFACTURING	ASSEMBLY		RATE	
IP Amp	1				90			
Mod/Demod	1				50			
Pwr Supply	ı				150			
Processor Board	-				25			
Power Amp	~				125			
Preselector					50			
LP Filter	-				50			
Pront Panel	7				25			
Covers	Lot				25.			
Alianment	3				009			
Burn-In	1				200			
Test	,				2050			
					Ş			
TOTALS					3700			

APPENDIX B

MATHEMATICAL FORMULATION OF THE COST MODEL

CONTENTS

																							-	age
1.	GENERAL DISCRIPTION	V .	•	•	•	•		•	•	•	•	•	•	•	•	•		•	•		•	•		B~3
2.	PROGRAM FEATURES		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•-	B-4
3.	MODEL FORMULATION																							B-6

APPENDIX B

1.0 GENERAL DESCRIPTION

ARINC Research Corporation's Life Cycle Cost Model (LCCM) has been adapted to evaluate the economic impact of proposed Discrete Address Beacon Systems (DABS) and to provide a basis for cost comparisons among the several DABS concepts under development. Twenty different concepts are being evaluated within the current ARINC Research study. The model evaluates each of these concepts in the Low Performance General Aviation user community.

The model itself is an expected value model which has been programmed in FORTRAN IV + for evaluations using a Digital Equipment Corporation PDP-11/34 minicomputer. The model computes the expected acquisition, installation, and logistic support costs by year and cumulatively for each concept. The program is designed for flexibility so that data changes can be readily implemented, sensitivity analyses performed, or additional data outputs obtained.

2.0 PROGRAM FEATURES

The DABS LCCM implementation consists of a common main program, called LCCOST, and seven subroutines, each designed to perform a specific function within the model. The seven routines and their functions are:

- (1) COSACQ Calculates the cost of acquisition of the DABS transponders by year and cumulative.
- (2) COSINS Calculates the cost of installation of the transponders by year and cumulative.
- (3) COSLOG Calculates the nonrecurring (investment) and recurring (operation and maintenance) costs of the DABS systems throughout their life cycle.
- (4) TOTCUM Determines the total equipment costs incurred each year and cumulative.
- (5) PERGAC Determines the annual cost per GA aircraft owner, as well as the annual cost per GA aircraft for the avionics equipment.
- (6) DISCNT Discounts constant dollars figures according to the guidelines set forth by the FAA.
- (7) OUTTAB Prints in table form the results of all the above computations.

Twenty-one input data files were used in exercising the DABS LCCM; one for each of the twenty configurations to be evaluated, and one user file called GENERAL tailored to the GA community. The system and user file names are specified at the beginning of the program's exercise from the teletype terminal keyboard, as are the number of years in the life cycle and the discount rate. The program then calls the designated files and reads them to obtain the specific data parameters used in the evaluation.

The specific outputs of the model, as dictated by the OUTTAB module, are:

- (1) The total acquisition cost for the GA user category and designated system by year and cumulative.
- (2) The total installation cost for the GA user category and system by year and cumulative.
- (3) The total nonrecurring logistic support cost for the GA user category and system by year.
- (4) The total recurring logistic support cost for the GA user category and system by year.
- (5) The total logistic support cost for the GA user category and system by year and cumulative.
- (6) The total cost for the GA user category and system by year and cumulative.
- (7) The detailed cost element breakdowns of the nonrecurring, recurring and total logistic support costs for the GA user category and system by year.
- (8) The cost per year to the GA aircraft owner and the cost per GA aircraft per year.

3.0 MODEL FORMULATION

The following describes the mathematical formulation of the DABS LCCM which has been implemented into the program LCCOST. The model computes on a yearly and cumulative basis the acquisition, installation, logistic support costs, and their totals for a given DABS system concept in the time period 1987-2002. The parameter definitions used in the model are presented after each set of formulas as well as in Appendix C.

3.1 Acquisition Costs

The acquisition costs are determined by the number of DABS systems purchased by the general aviation community each year and the average unit cost of the systems during the year (reflecting learning curves and amortization costs, if applied). The acquisition costs for year i are given by:

$$ACOS_{i} = (NAV) (CRFT_{i}) (FUCOS_{i}) + AMCOS; i \le 2$$

$$= (NAV) (CRFT_{i}) (FUCOS_{i}) ; i > 2$$

where:

$$CRFT_i = NAC_i + NRAC_i$$

The cumulative acquisition cost is simply:

$$T\cos A_i = \sum_{j=1}^i A\cos_i$$

Variables are:

NAV = average no. of avionics systems per aircraft

FUCOS, = average system cost in year i

AMCOS = amortization cost

NAC, = no. of new aircraft in year i

 $NRAC_{i}$ = no. of aircraft retrofitted in year i

3.2 Installation Costs

The installation cost in the i'th year is determined by the number of DABS units installed in new aircraft or retrofitted into existing aircraft that year multiplied by the appropriate per unit installation rate. The resultant installation cost equation is given by:

$$ICOS_{i} = (NAV)[(NRAC_{i})(RICOS) + (NAC_{i})(INCOS)]$$

The cumulative installation cost is given by:

$$TCOSI_i = \sum_{j=1}^{i} ICOS_i$$

Variables are:

NAV = average no. of avionics systems per aircraft

NRAC, = no. of aircraft to be retrofitted in year i

RICOS = retrofit installation cost per system

 $NAC_{i} = no.$ of new aircraft in year i

INCOS = new aircraft installation cost per system

3.3 Logistic Support Costs

The logistic support cost is considered to be composed of the sum of eight cost elements, each having a nonrecurring (investment) and recurring (operating and maintenance) cost component. Hence, the logistic support cost in the i'th year is given by:

$$LCOS_{i} = \sum_{j=1}^{8} [NRCOS_{i,j} + RLCOS_{i,j}],$$

with NRCOS; representing the nonrecurring costs and RLCOS; representing the recurring costs. Similarly, the cumulative nonrecurring, recurring, and logistic support costs for year i are given by:

$$TCOSN_{i} = \sum_{j=1}^{i} TNRCOS_{j}$$

$$TCOSR_{i} = \sum_{j=1}^{i} TRLCOS_{j}$$

$$TCOSL_i = \sum_{j=1}^{i} LCOS_j$$

where:

TNRCOS_j =
$$\sum_{k=1}^{8}$$
 NRCOS_{j,k}

TRLCOS_j =
$$\sum_{k=1}^{8}$$
 RLCOS_{j,k}

The following paragraphs present the methodology for determining the individual cost elements and their components.

3.3.1 Initial and Replacement Spares

This cost element consists of the expenses associated with the procurement of the spares inventory. The nonrecurring component is the expenditure in the i'th year to purchase the spares required to satisfy the expected demand with a given level of spares sufficiency. In determining the nonrecurring costs, assumptions which should be noted are:

- (1) A minimum of one spare of each type of the principal modules, or LRUs, and sub-modules, or SRUs, is assumed for each base.
- (2) A minimum of one spare of each type LRU and SRU is assumed for each depot.

The recurring spares cost represents the cost of purchasing additional spares to replace those lost to the logistic system through condemnation and attrition.

```
The resultant components are given by:
```

$$NRCOS_{i,1} = \sum_{j=1}^{NLRU} [(NLSPRS_{i,j})(LUCOS_{j}) + \sum_{k=1}^{NSRU_{j}} (NSSPRS_{i,j,k})(SUCOS_{j,k})]$$

where, for nonrepairable LRUs:

and:

FBLRU = BIT + (1-BIT) (RTSS)

$$TFAV_{i} = (12) (AFHR) (NS_{i})$$

$$NS_{i} = \sum_{j=1}^{i} (NAV) (CRFT_{j})$$

 $RDUM = (TFAVI_i)(ROP)/LMTBF_i$

where, for repairable LRUs:

and:

YDUM =
$$(TFAV_i)$$
 (FBLRU) (RTS_j) (BMT)/[(NOB_j) (LMTBF_j)]
ZDUM = $(TFAV_i)$ (FBLRU) (1-RTS_j) (DMT)/[(NOD_i) (LMTBF_j)]

```
where, for nonrepairable SRUs:
```

and:

where, for repairable SRUs:

$$\text{NSSPRS}_{i,j,k} = \left\{ \left[\text{Max[INT[(NOB_i)(XDUM + SUF(3)\sqrt{XDUM})]}, \right. \right. \\ \left. \left(\text{XMINB}(NOB_i)/LCOMS_{j,k} \right] \right\} \\ \left. + \left\{ \text{Max[INT[(NOD_i)(YDUM + SUF(3)\sqrt{YDUM})]}, \right. \right. \\ \left. \left(\text{XMINB}(NOD_i)/LCOMS_{j,k} \right] \right\} - \text{NSPRB}_{j,k} \\ \left. \left(\text{RLCOS}_{i,1} = \sum_{j=1}^{NLRU} \left[\left(\text{RLSPRS}_{i,j} \right) \left(\text{LUCOS}_{j} \right) + \sum_{k=1}^{NSRU} \left(\text{RSSPRS}_{j,k} \right) \left(\text{SUCOS}_{j,k} \right) \right] \right.$$

where:

Variables are:

NOB; = no. of bases in year i

NOD; = no. of depots in year i

SUF(2) = LRU spares suffuciency factor

NSPRL; = no. LRU; spares purchased prior to year i

BSOBL = base LRU stocking objective

BSODL = depot LRU stocking objective

OSBL = average LRU order/ship time, base

OSDL = average LRU order/ship time, depot

ROP = requirements objectives period

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

RTSS = fraction of failures isolated to LRU level at base without using BITE

AFHR = average monthly flight operating hours

NS; = no. of systems in operation in year i

NAV = average no. of avionics units per aircraft

CRFT, = no. of aircraft receiving avionics in year i

NLRU = no. of LRUs in system

LUCOS; = unit cost of jth LRU

NSRU, = no. of SRUs in j'th LRU

SUCOS; k = unit cost of k'th SRU in j'th LRU

MINB = minimum no. of each type LRU spare

 $LCOML_{\frac{1}{2}}$ = no. of avionics unit types to which LRU, is common

 $RTS_{ij} = fraction of LRU_{ij}$ failures isolated to SRU at base

BMT = base turnaround time

 $LMTBF_{j}$ = mean time between failures of j'th LRU

DMT = depot turnaround time

SUF(3) = SRU spares sufficiency factor

NSPRB $_{j,k}$ = no. of SRU $_{j,k}$ spares purchased prior to year i

BSOB = base SRU stocking objective

SMTBF_{j,k} = mean time between failures of SRU_{j,k}

BSOD = depot SRU stocking objective

OSB = average SRU order/shiptime, base

OSD = average SRU order shiptime, depot

XMINB ≈ minimum no. of each type SRU spare

 $LCOMS_{j,k} = no.$ of LRUs to which $SRU_{j,k}$ is common

 $COND_{j} \approx fraction of LRU_{j}$ failures that are condemned

 $CONDB_{j,k}$ = fraction of $SRU_{j,k}$ failures that are condemned

 $ITWL_{i} = repair/throw-away flag for LRU_{i}$

ITWS_{j,k} = repair/throw-away flag for $SRU_{j,k}$

3.3.2 On-Aircraft Maintenance

This cost element represents the expected expenditures in performing on-aircraft corrective maintenance. This element contains only a recurring cost component, i.e., $NRCOS_{i,2} = 0$, and represents the costs associated with remove and replace actions, as well as preventive maintenance actions. The cost is determined as follows:

$$RLCOS_{i,2} = \sum_{j=1}^{NLRU} [(TFAV_i)(RMHB_j)/LMTBF_j] + (NS_i)(FPM)(PMMH) \} (BLR)$$

where:

$$TFAV_i = (12) (AFHR) (NS_i)$$

Variables are:

NLRU = no. of LRUs in avionics system

 $RMHB_{j}$ = average time to remove and replace j'th LRU

 LMTBF_{j} = mean time between failures of j'th LRU

NS; = no. of systems in operation in year i

FPM = frequency of preventive maintenance

PMMH = average time required to complete preventive maintenance actions

AFHR = average monthly flight operating hours

3.3.3 Off-Aircraft Maintenance

The expected material, labor, shipping, and documentation costs associated with performing corrective maintenance at the base and depot locations are represented by this cost element. Like the on-aircraft maintenance cost element, off-aircraft maintenance consists of a recurring cost component only, i.e., NRCOS_{i.3} = 0. This component is determined by:

$$RLCOS_{i,3} = TMAT_{i} + TLABOR_{i} + TSHIP_{i} + BDMTD_{i} + DDMTD_{i}$$

where:

```
and:
     XLTTR_{i} = \sum_{j=1}^{L} (WT_{j}) (COND_{j}) / LMTBF_{j}
               NLRU NSRUj

\Sigma \Sigma (WTB j,k) (CONDB j,k)/SMTBF j,k

j=1 k=1
     XLSHP_{i} = \sum_{i=1}^{\infty} [(WT_{i})[(FBLRU)[(1-RTS_{i})+(RTS_{i})(1-RTLB_{i})]
               (2) (YMIL) (SSHC) (1-ITWL; )+[ (FBLRU) (1-RTS; )
               (YMIL) (SSHC) (1-ITWS_{j,k})+(FBLRU) (RTS_{j}) ((YMIL) (SSHC)+
                (XMIL)(SHC))(ITWS;,k)]/SMTBF;,k]
     TFAV_{i} = (12) (AFHR) (NS_{i})
     FBLRU = BIT+(1-BIT)(RTSS)
where:
    BDMTD_{i} = (BDOC + (LRUT + SRUT) (TFR)) (TFAV_{i}) (BLR)
     DDMTD; = (DDOC + (LRUT + SRUT) (TFR)) (TFAV;) (DLR)
and:
     BDOC = (ONAC + OFAC + STR)/UMTBF
     DDOC = (OFAC + STR) / UMTBF
             NLRU
            Σ (FBLRU) (1-RTS ) /LMTBF
     LRUT =
```

NSRU_j Σ (FBLRU)(RTS_j)(1-RTSB_j,k)/SMTBF_j,k

SRUT =

Variables are:

NLRU = no. of LRUs in avionics system RTS_{i} = fraction of LRU_{j} failures isolated to SRU at base $\mathtt{RTLB}_{\dot{1}}$ = fraction of repairable $\mathtt{LRU}_{\dot{1}}$ failures repaired at base $BMC_{\dot{1}}$ = average base materials cost per maintenance action on j'th LRU DMC_{j} = average depot materials cost per maintenance action on j'th LRU $LMTBF_{j}$ = mean time between failures of j'th LRU $NSRU_{j} = no. of SRUs in j'th LRU$ $RTSB_{i,k}$ = fraction of repairable $SRU_{i,k}$ repaired at base BMCS; k = average base materials cost per maintenance action on SRU; k DMCS; k = average depot materials cost per maintenance action on SRU; k SMTBF; k = mean time between failures of SRU; k LMTTR; = mean time to repair j'th LRU ITWL; = repair/throw-away flag for j'th LRU BLR = base labor rate SMTTR; = mean time to repair SRU; k DLR = depot labor rate ITWS; k = repair/throw-away flag for SRU; k PACK = packaging factor = packed wt./unpacked wt. YMIL = average no. of shipping zones between base and depot SSHC = shipping rate per lb between base and depot XMIL = average no. of shipping zones to first destination SHC = shipping rate per lb to first destination $WT_j = weight of j'th LRU$

COND, = fraction of failed LRU, that are condemned

WTB i.k = weight of SRU i.k

CONDB_{j,k} = fraction of failed SRU_{j,k} that are condemned

AFHR = average monthly flight operating hours

 NS_i = no. of systems in operation in year i

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

RTSS = fraction of failures isolated to LRU at base without using BITE

ONAC = time required to complete on-aircraft maintenance records

OFAC = time required to complete off-aircraft maintenance records

STR = time required to complete supply transaction records

TFR = time required to complete transportation forms

UMTBF = mean time between system failures

3.3.4 Inventory Entry and Supply Management

This cost element represents the cost associated with introducing and maintaining new coded supply items in the user inventory and the management cost of maintaining a supply inventory for all of the coded items that are stocked at the repair sites. The first year's inventory entry cost is treated as a nonrecurring cost (NRCOS_{i,4}); the supply management cost is treated as a recurring cost throughout (RLCOS_{i,4}). The resultant components are given by:

$$NRCOS_{i,4} = (IAMC) (NIC) (TIC) (NICB); i = 1$$

= 0 ; i \neq 1

where:

NICB = 1; FRAV
$$\neq$$
 0.
= 0; FRAV = 0.

and:

$$RLCOS_{i,4} = [(NOB_i)(NOIB)(HOLDB) + (NOD_i)(NOID)(HOLDD)](NICB); i = 1$$

$$= [(IAMC)(NIC)(TIC) + (NOB_i)(NOIB)(HOLDB) + (NOD_i)(NOID)(HOLDD)]$$

$$(NICB); i \neq 1$$

Variables are:

IAMC = cost of introducing each new coded item

NIC = faction of inventory coded items that are new

TIC = total no. of inventory coded items

NOB; = no. of bases in year i

NOIB = no. of different item types stocked at base

HOLDB = average annual holding cost per item type, base

NOD; = no. of depots in year i

NOID = no. of different item types stocked at depot

HOLDD = average annual holding cost per item type, depot

3.3.5 Special Support Equipment

Included in this cost element are the nonrecurring costs of purchasing special test equipment (NRCOS $_{i,5}$) and the recurring costs of operating that equipment (RLCOS $_{i,5}$). It is assumed in the model that the test equipment is unique to the systems being evaluated. It is further assumed that there will be a minimum of one of each type of support equipment at each base and depot facility. The nonrecurring and recurring costs of special support equipment in the i'th year, assuming that NSEB $_{\dot{m}}$ and NSED $_{\dot{m}}$ units of the m'th equipment type have been purchased prior to year i at the base and depot level, are given by:

 $NRCOS_{i,5} = NNSEB_i + NNSED_i$

```
where:
```

and:

$$RLCOS_{i,5} = RNSEB_i + RNSED_i$$

where:

Variables are:

PFHR = peak monthly flight operating hours

BMH(1) = average labor hours to isolate failure in principal electronics to SRU level

UTILE = utilization rate of m'th type support equipment

UMTBF = mean time between system failures

BETA = base support equipment hours available per month

AVALB = availability of m'th type support equipment, base

MINSEB = minimum no. of each type support equipment, base

LCOMB = no. avionics unit types to which m'th type base support equipment is common

 $USECOB_{m} = unit cost of m'th type base support equipment$

JSEB = no. of different types base support equipment

NOB; = no. of bases in year i

JSED = no. of different types depot support equipment

NOD; = no. of depots in year i

UTILD = utilization rate of m'th type depot support equipment

DETA = depot support equipment hours available per month

 $AVALD_m = availability m'th type depot support equipment$

MINSED = minimum no. of each type depot support equipment

 $LCOMD_{m}$ = no. of avionics unit types to which m'th type depot support equipment is common

 $\mathtt{USECOD}_{\mathtt{m}} = \mathtt{unit} \ \mathtt{cost} \ \mathtt{of} \ \mathtt{m'th} \ \mathtt{type} \ \mathtt{depot} \ \mathtt{support} \ \mathtt{equipment}$

NS; = no. of systems in operation in year i

SECOB = support equipment operating cost, base

MSEBO = minimum annual support equipment operating cost, base

SECOD = support equipment operating cost, depot

MSEDO = minimum annual support equipment operating cost, depot

3.3.6 Training

The training cost consists of the specialized maintenance training required to meet the expected corrective maintenance demands (NRCOS_{1,6}) and the recurrent cost of additional specialized training resulting from the turnover of repair personnel (RLCOS_{1,6}). It is assumed that a minimum of one person per maintenance

site will receive training. The training costs incurred in year i, then, assuming that NPERB base personnel and NPERD depot personnel have been trained prior to year i are:

and:

 $RLCOS_{1,6} = (NPERB) (TCOSB) (TRB) + (NPERD) (TCOSD) (TRD)$

 $+(\texttt{FBLRU}) \big[(\texttt{l-RTS}_{\texttt{j}}) + (\texttt{RTS}_{\texttt{j}}) (\texttt{l-RTSB}_{\texttt{j},k}) \big] \big] (\texttt{SMTTR}_{\texttt{j},k}) / (\texttt{SMTBF}_{\texttt{j},k}) \big] \big] \big\}$

Variables are:

TCOSB = training cost per base repair person

TCOSD = training cost per depot repair person

AMHB = average labor-hours per maintenance action, base

UMTBF = mean time between system failures

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

BMHS = average labor-hours to isolate failure to LRU at base

NLRU = no. of LRUs in avionics system

BMH; = average labor-hours to isolate failures in j'th LRU to SRU level at base

 $RTS_j = fraction LRU_i$ failures isolated to SRU at base

RTLB; = fraction of repairable LRU; repaired at base

LMTTR, * mean time to repair LRU,

LMTBF; = mean time between failures j'th LRU

NSRU; = no. of SRUs in j'th LRU

 $RTSB_{j,k} = fraction of repairable SRU_{j,k}$ repaired at base

SMTTR_{j,k} = mean time to repair SRU_{j,k}

SMTBF_{j,k} = mean time between failures of SRU_{j,k}

PMB = available hours per year per repair person, base

PRODB = productivity of base repair personnel

MINBP = minimum no. repair personnel per base

NOB; = no. of bases in year i

AMRD = average labor-hours per maintenance action, depot

RTSS = fraction of failures isolated to LRU at base

DMHS = average labor-hours to isolate failure to LRU at depot

DMH; = average labor-hours to isolate failures in j'th LRU to SRU level at depot

PMD = available hours per year per repair person depot

PRODD = productivity of depot repair personnel

MINDP = minimum no. repair personnel per depot

NOD, = no. of depots in year i

AFHR = average monthly flight operating hours

NS; = no. of systems in operation in year i

TRB = turnover rate, base repair personnel

TRD = turnover rate, depot repair personnel

3.3.7 Data Management and Technical Documentation

The data management and technical documentation element consists only of the nonrecurring cost $(NRCOS_{i,7})$ associated with the preparation of base and depot level documentation $(RLCOS_{i,7}=0)$. These costs are given by the equation:

$$NRCOS_{i,7} = (CPP)[(NPDB)(NNBAS_i) + (NPDD)(NNDEP_i)]$$

where:

NNBAS_i = NOB_i ; i = 1
= NOB_i-NOB_(i-1); i
$$\neq$$
 1
NNDEP_i = NOD_i ; i = 1
= NOD_i-NOD_(i-1); i \neq 1

Variables are:

CPP = cost per page, original technical documentation

NPBD = no. of pages base level documentation

NPDD = no. of pages depot level documentation

NOB, = no. of bases in year i

NOD, = no. of depots in year i

3.3.8 Facilities

The facilities costs are considered to consist of the recurring operating costs of the repair facilities (e.g., space rent, electricity, general tools, etc.). It is assumed that no new support facilities will be required for the system; hence, NRCOS_{i,8} = 0. The recurring cost (RLCOS_{i,8}) is then given by:

$$RLcos_{i,8} = (FOCB)(NOB_i) + (FOCD)(NOD_i)$$

Variables are:

FOCB = annual base facilities cost attributable to system being analyzed

FOCD = annual depot facilities cost attributable to system being analyzed

NOB; = number of base maintenance sites, year i

NOD; = number of depot maintenance sites, year i

APPENDIX C

LIFE-CYCLE-COST MODEL PROGRAM

THE PROGRAM LCCOST DETERMINES THE TOTAL LIFE CYCLE COST OF SPECIFIED AVIONICS UNIT(S). DATA IS INPUT TO THE PROGRAM BY MEANS OF THE USER TERMINAL, A SYSTEM FILE (SFILE). AND A USER FILE (UFILE). THE PROGRAM USES THE DATA TO DETERMINE

C 1 ANNUAL ACQUISITION COSTS, INSTALLATION COSTS, AND LOGISTIC SUPPORT COSTS, WHICH ARE THEN OUTPUT IN TABULAR FORM IN BOTH CONSTANT AND DISCOUNTED BOLLARS.

PROGRAM LCCOST

***ESTABLISH COMMON BLOCKS**

COMMON/ACQUIZ/ACOS(25), TCOSA(25) COMMON/ARCRET/CRET(25), NAC(25), NRAC(25), YEAR(25) COMMUN/CAT/CLCC, TNRCAT(9), TRLCAT(9), TFROG(25), CFROG(25) COMMON/INSTAL/ICOS(25), TCOSI(25) COMMON/LOGIST/NRCOS(25:8); RLCOS(25:8); TCOSL(25); TLLCOS(25); TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25) COMMON/MISCLO/ NBAS(25), NDEP(25), UMTBF COMMON/SYSTEM/BMC(20),BMCS(20,20),COND(20),CONDE(20,20),DMC(20), DMCS(20,20), ITWL(20), ITWS(20,20), LCOML(20), LCDMS(20,20),LMTBF(20),NLRU,NSRU(20),RMHB(20), RTS(20),RTSB(20,20),SMTBF(20,20) 3 COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV, PQTY, RICOS, SUCOS(20,20), WT(20), WTB(20,20), XLRN, BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTR(20,20) COMMON/NAMES/SNAME; UNAME

*DECLARE VARIABLES AND DATA

INTEGER BEGYR, ENDYR, ITWL, ITWS, LCOML, LCOMS, NBAS, NDEF, NLRU, NNB, NND INTEGER NOBAS, NODER, NREYR, NSRU, NUM, NYRS, YEAR, YR, BASEYR REAL AMCOS, BMC, BMCS, COND, CONDB, DIST, DMC, DMCS, FRAV, FUCOS, ICOS REAL INCOS, LMTBF, LUCOS, NAC, NNAC(25), NRAC, PRTY, RICOS, RMHB REAL RTS,RTSB-SMTBF,SUCOS,TNRAC,UMTBF,WT,WTB,XDIS,XLRN,LMTTR:MRCOS REAL LDIST, SDIST, KFAC LOGICAL*1 ANS, SNAME(65), UNAME(35), SFILE(16), UFILE(16) DATA SFILE//S',/Y',/O'-/:/,6*'X',',','D','A','T',0,0/ DATA UFILE//3/,/Y/,/O/,/\$/,6*/Y/,/,/,/D/,/A/,/T/,0,0/ DATA UMTBE/0.0/, SNAME/65*0/, UNAME/35*0/

C C

1.0

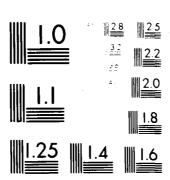
C

*INITIALIZE TERMINAL INPUT VARIABLES

WRITE(1,k) /----AVIONICS LIFE CYCLE COST EVALUATION-----URITE(1,*) / WRITE(1,%) / WRITE(1,*) 'ENTER NUMBER OF SYSTEMS TO BE EVALUATED IN THIS RUM READ(1,1001) NUM WRITE(198) (

```
WRITE(1,*) 'SYSTEM FILE NAME?'
20
      READ(1,1002) (SFILE(I), I = 5, 10)
      切RITE(19米) (
      WRITE(1,*) 'USER FILE NAME?'
30
      READ(1,1002) (UFILE(I), I = 5,10)
      WRITE(1,*) (
      WRITE(1,*) 'NUMBER OF YEARS IN LIFE CYCLE?'
      READ(1,1001) NYRS
      WRITE(1,*) /
      WRITE(1,*) 'DISCOUNT RATE?'
      READ(1,1003) XDIS
      WRITE(1,*) /
      WRITE(1,*) 'BASE YEAR FOR DISCOUNTING PURPOSES? (5.6. 1980)/
      READ(1,1013) BASEYR
      WRITE(1,*) /
      WRITE(1,*) 'VALUE OF K FACTOR (FOR MTBF SENSITIVITY ANALYSIS)?'
      WRITE(1,*) '(NOTE:ENTER 1.0 IF YOU DO NOT WISH TO PERFORM THE'
      WRITE(1,*) 'SENSITIVITY ANALYSIS.)'
      READ(1,1003) KFAC
      WRITE(1,*) /
C
\mathbb{C}
     *READ DATA FROM SYSTEM AND USER FILES
C
      OPEN(UNIT=2,NAME=SFILE,TYPE='OLD',READONLY,ERR=901)
      OPEN(UNIT=3,NAME=UFILE,TYPE='OLD',READONLY,ERR=902)
40
      READ(2,1004) (SNAME(I), I = 1, 65)
      READ(3,1004) (UNAME(I), I = 1, 35)
C
\mathbb{C}
     *INITIALIZE YEAR, NNAC, NRAC, NBAS, AND NDEP ARRAYS BY READING
С
     *APPROPRIATE DISK FILE
C
      DO 50 I = 1, NYRS
        READ(3,1006) YEAR(I), NNAC(I), NRAC(I), NBAS(I), NDER(I)
50
      CONTINUE
C
      DO 100 N = 1, NUM
        READ(2,1010) UCOS, AMCOS, PRTY
        READ(3,1005) INCOS, RICOS, DICT, LDIST, SDIST
        READ(3,1012) NAV, FRAV, XLRN
C
        DO 55 I = 1, NYRS
C
С
         *DETERMINE NUMBER OF NEW AIRCRAFT IN AVIONICS FLEET IN YEAR I
          NAC(I) = AINT(FRAV*NNAC(I))
35
        CONTINUE
C
C
       *CALCULATE ACQUISITION AND INSTALLATION COSTS
C
        CALL COSACQ(NYRS,UCOS,DIST)
C
\mathbf{C}
       *CALCULATE THE COST OF EACH LRU AND BRU, TAKING INTO
       *CONSIDERATION DEALER MARK-UP/-DOWN
```

```
0
        READ(2,1006) RERU
        BO 70 I = 1, NLRU
          READ(2,1004)
          READ(2:1007) LUCOS(I):LMTRF(I):ITWL(I):LCGML(I)
          READ(2,1008) WT(I),RTS(I).COND(I),NSRU(I)
          READ(2,1005) RMHB(I),BMC(I),DMC(I)
          READ(2,1005) BMH(I),DMH(I),RTLE(I),LMTTR(I)
          LUCOS(I) = LUCOS(I)*(1 + LDIST)
          LMTBF(I) = LMTBF(I)/KFAC
          BMC(I) = BMC(I)*KFAC
          DMC(I) = DMC(I)*KFAC
           IF (MSRU(I) .EQ. 0) GO TO 60
          DO 60 J = 1 \cdot NSRU(I)
             READ(2,1004)
             READ(2,1007) SUCOS(I,J),SMTBF(I,J),ITWS(I,J),LCOMS(I,J)
             READ(2,1008) WTB(I,J),RTSB(I,J),CONDB(I,J)
             READ(2,1005) BMCS(I,J),DMCS(I,J),SMTTR(I,J)
             SUCOS(I,J) = SUCOS(I,J)*(1 + SDIST)
             SMTBF(I,J) = SMTBF(I,J)/KFAC
             BMCS(I_*J) = BMCS(I_*J)*KFAC
             DMCS(I_{+}J) = DMCS(I_{+}J)*KFAC
60
           CONTINUE
70
        CONTINUE
\mathbb{C}
\mathbb{C}
       *CALCULATE MTBF FOR SYSTEM
\mathbb{C}
        00 \ 90 \ I = 1, NLRU
          UMTBF = UMTBF + 1./LMTBF(I)
90
        CONTINUE
        UMTBF = 1./UMTBF
\mathbb{C}
C
       *CALCULATE LOGISTIC SUPPORT COST OF AVIONICS SYSTEM
C
        CALL COSLOG(NYRS;OWNER)
\mathbb{C}
\mathbf{C}
       *REPEAT CALCULATIONS FOR NEXT AVIONICS SYSTEM TO BE EVALUATED
C
1.00
      CONTINUE
C
0
     *CALCULATE TOTALS FOR LIFE CYCLE
      CALL TOTCUM(NYRS)
C
С
     *FRINT ANNUAL COST PER OWNER AND PER AIRCRAFT
C
      DSCNT = 0.0
      CALL PERGAC(NYRS, DSCNT)
C
     *PRINT ANNUAL LOGISTIC SUPPORT COSTS BY CATEGORY AND TOTAL LIFE
C
     *CYCLE COSTS BY YEAR
      CALL OUTTAB(NYRS,DSCNT)
```



MICROCOPY RESOLUTION TEST CHART NATIONAL HORSES AS A CONTROL OF THE CHART

```
\mathbf{C}
C
     *CALCULATE AND PRINT DISCOUNTED ANNUAL LOGISTIC SUFFORT COSTS
C
     *BY CATEGORY AND DISCOUNTED TOTAL LIFE CYCLE COSTS BY YEAR
C
      CALL DISCNT(NYRS, XDIS, BASEYR)
      CALL TOTOUM(MYRS)
      CALL PERGAC(NYRS:XDIS)
      CALL OUTTAB(NYRS, XDIS)
\mathbb{C}
Ű.
     *CLOSE INPUT FILES
O
      CLOSE(UNIT=2,ERR=903)
      CLOSE(UNIT=3,ERR=904)
С
      GO TO 999
\mathbb{C}
     *ERROR STATEMENTS
C
901
      WRITE(1,*) 'ERROR IN OPENING SFILE, PLEASE TRY AGAIN.'
      GO TO 20
C
902
      WRITE(1,*) 'ERROR IN OPENING UFILE, PLEASE TRY AGAIN,'
      CLOSE (UNIT=2, ERR=903)
      GO TO 30
C
903
      WRITE(1.*) 'ERROR IN CLOSING SFILE, PROGRAM ABORTED,'
      GO TO 999
\mathbf{C}
904
      WRITE(1:*) 'ERROR IN CLOSING UFILE, PROGRAM ABORTED.'
C
C
     *FORMAT STATEMENTS
C
1001
     FORMAT(I2)
      FORMAT(10A1)
1002
      FORMAT(F4.2)
1003
1004
      FORMAT(20X,65A1)
      FORMAT(10X,F8,2,3(7X,F8,2),7X,F4,2)
1005
1006
      FORMAT(10X, 18, 7X, F8, 0, 7X, F8, 0, 7X, 18, 7X, 12)
1007
      FORMAT(10X,2(F8.2,7X),18,7X,18)
      FORMAT(10X,2(F8,2,7X),F8,3,7X,18)
1008
1009
      FORMAT(10X, 18, 7X, F8, 2)
1010
      FORMAT(10X,F8,2,7X,F8,1,2(7X,F8,2))
1011
      FORMAT(10X,4(I8,7X))
      FORMAT(10X,18,3(7X,F8,3))
1012
      FORMAT(I4)
1013
999
      STOP
      END
```

BUBROUTINE COSACO

THE COGACO MODULE DETERMINES THE ACCUISITION COST OF THE SPECI-FIED AMIONICS EQUIPMENT FOR EACH YEAR IN THE LIFE CYCLE. ACOS REPRESENTS THE ACQUISITION COSTS INCURRED IN YEAR I: TOOSA REP-RESENTS THE TOTAL ACQUISITION COSTS INCURRED PRIOR TO YEAR I. Ċ SUBROUTINE COSACO(NYRS:UCOS:DIST) KESTHBLISH COMMON BLOCKS COMMON/ACQUIZ/ACOS(25), TCOSA(25) COMMON/ARCRET/CRFT(25), NAC(25), NRAC(25), YEAR(25) COMMON/INSTAL/ICOS(25), TCOSI(25) COMMON/VIONIX/AMCOS, FRAY, FUCOS, INCOS, LUCOS(20): NAV, 1 PRTY, RICOS, SUCOS(20,20), NT(20), WTB(20,20), XLRM, BMH(20), BMH(20), RTLB(20), LMTTR(20), SMTTR(20,20) \mathbb{C} RDECLARE VARIABLES INTEGER NYRS, YEAR REAL ACOS, AMCOS, COST, CRFT, FRAV, FUCOS, ICOS, INCOS, LUCOS REAL NACINFURINRACIRICOSISUCOSITOOSA, TOOSI, WT, UTB, LMTTR, LC LOGICAL*1 ANS DATA ACOS/25%0.0/, TCOSA/25%0.0/ Ĉ. *IMITIAL PRODUCTION COSTS ARE AMORTIZED OVER THE FIRST *TWO YEARS OF PRODUCTION AMCOS = AMCOS/(2.0*PQTY)Tary = 0.0 AMS = 17DO 10 I = 1, NYRS 1.1 FUCOS = UCOS ť, *COST IS GREATER IF AMORTIZING INITIAL PRODUCTION COSTS Γ *(START-UP COSTS ARE AMORTIZED OVER FIRST TWO YEARS OF 0 *PRODUCTION.) IF (I .LE. 2) FUCOS = UCOS + AMCOS C \mathbb{C} *IS THE LEARNING CURVE TO BE USED? C IF (ANS .ME, 'Y') GO TO 5 IF (I ,NE. 1) GO TO 2 WRITE(1.K) 'IS THE LEARNING CURVE FACTOR TO BE APPLIEDT' READ(1:1001) ANS WRITE(19*) / IF (ANS ,NE, 'Y') GO TO 5

LC = (TQTY + PQTY/2.)**(ALGG(XLRN)/ALGG(2.0))

TRTY = TRTY + PRTY FUCOS = FUCOS * LC

2

```
MAGINST FUCOS TO REFLECT DEALER MARK-UPL-DOWN
        FUCOS = FUCOS*(1 + DIST)
*DETERMINE NUMBER OF A/C IN WHICH SYSTEM IS TO BE INSTALLED
       RIN YEAR I
       *IF (RETROFIT PERIOD IS OVER) MRAC(I) = 0
O
        CRFT(I) = NAC(I) + NRAC(I)
\mathbb{C}
       *CALCULATE NUMBER OF AVIONICS UNITS PURCHASED IN YEAR I
C
        NPUR = NAV*CRFT(I)
C
C
       *CALCULATE COST ASSOCIATED WITH ACQUISITION OF AVIONICS UNITS IN
C
       *YEAR I
\mathbf{C}
        COST = NFUR*FUCOS
       **UPDATE ACQUISITION COSTS FOR YEAR I
C
        ACOS(I) = ACOS(I) + COST
Ĉ
       *CALCULATE INSTALLATION COST FOR FLEET
C
        CALL COSINS(NYRS,I)
10
      CONTINUE
1001
      FORMAT(2A1)
      RETURN
      END
```

SUBROUTINE COSINS

THE COSINS MODULE DETERMINES THE INSTALLATION COST OF THE SPECIFIED AVIONICS EQUIPMENT FOR EACH YEAR IN THE LIFE CYCLE. ICOS REPRESENTS THE INSTALLATION COSTS INCURRED IN YEAR IS TOOSI REPRESENTS THE TOTAL INSTALLATION COSTS INCURRED PRIOR TO YEAR I.

SUPROUTINE COSINS(NYRS,I)

***ESTABLISH COMMON BLOCKS**

COMMON/ARCRET/CRFT(25), NAC(25), NRAC(25), YEAR(25)

COMMON/INSTAL/ICOS(25), TCOSI(25)

COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV,

PRTY, RICOS, SUCOS(20,20), NT(20), WTB(20,20), KLRN,

BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTE(20,20)

KURCLARE VARIABLES

 $\frac{0}{0}$

INTEGER NYRS, YEAR
REAL AMCOS, COST, CRFT, FRAV, FUCOS, ICOS, INCOS, LUCOS, NAC
REAL NRAC, POTY, RICOS, SUCOS, TCOSI, WT, WTB, XLRN, LMTTR
DATA ICOS/25*0.0/. TCOSI/25*0.0/

KCALCULATE INSTALLATION COST FOR YEAR I

COST = NAV*(NRAC(I)*RICOS + NAC(I)*INCOS)

*UPDATE INSTALLATION COSTS FOR YEAR I

ICOS(I) = ICOS(I) + COST RETURN END

READ(2,1001) BIT,RTSS,ROP

READ(3,1005) IAMC, NIC, TIC

READ(3,1006) BSOBL,BSODL,OSBL,OSDL READ(3,1006) BSOB,BSOD,OSB,OSD READ(3,1001) FFM,FMMH,CPF,FACK READ(3,1001) YMIL,XMIL,SSHC,SHC READ(3,1001) ONAC,OFAC,STR,TFR

```
READ(3,1001) HOLDB,HOLDD
      READ(3,1001) PRODB, PRODD, PMB, PMD
      READ(3,1002) BMT, DMT, NPBD, NPDD
      READ(3,1001) TOOSB, TOOSD, TRB, TRD
      READ(3,1001) BLR, DLR, FOCB, FOCD
      READ(3,1001) AFHR, PFHR, SUF(2), SUF(3)
      READ(3,1001) BETA, DETA
      READ(2,1003) NOIB, NOID
      READ(2,1001) BMHS, DMHS, SECOB, SECOD
      READ(2,1003) JSEB, JSED, MSEBO, MSEDO
C
      IF (USEB .EQ. 0) GO TO 2
      DO 2 M = 1, JSEB
        READ(2,1004) AVALB(M), LCOMB(M), USECGB(M), UTILB(M)
      CONTINUE
2
      IF (JSED .EQ. 0) GO TO 4
      DO 4 M = 1, JSED
        READ(2,1004) AVALD(M), LCOMD(M), USECOD(M), UTILD(M)
4
      CONTINUE
      READ(2,1007) MINB, XMINB, MINSEB, MINSED
C
     *INITIALIZE VARIABLES
C
     *ASSUMING A MINIMUM OF ONE REPAIR PERSON PER MAINTENANCE SITE
C
     *MINBP AND MINDP ARE BOTH SET TO 1.
      MINBP = 1
      MINDF = 1
      BASE = 0.0
      DEPOT = 0.0
      FBLRU = BIT + (1-BIT)*RTSS
C
     *CALCULATE AMHB AND AMHD
      DO 3 I = 1, NLRU
        BASE = BASE + FBLRU*(BMH(I)*RTS(I) + RTLB(I)*LMTTR(I))/LMTBF(I)
        DEPOT=DEPOT+((1-BIT)*(1-RTSS)+FBLRU*(1-RTS(I))*DMH(I) +
              FBLRU*(1-RTLB(I))*LMTTR(I))/LMTBF(I)
        IF (NSRU(I) .EQ. 0) GO TO 5
        DO 5 J = 1, NSRU(I)
          BASE = BASE + RTS(I)*(RTSB(I,J)*SMTTR(I,J))/SMTBF(I,J)
          DEPOT=DEPOT+(((1-BIT)*(1-RTSS)+FBLRU*((1-RTS(I))+(RTS(I))*(1-
                RTSB(I,J)))))*SMTTR(I,J)/SMTBF(I,J))
5
        CONTINUE
      CONTINUE
3
      AMHB = UMTBF*(((1-BIT)*BMHS)/UMTBF + FBLRU*BASE)
      AMHD = UMTBF*(((1-BIT)*(1-RTSS)*DMHS/UMTBF) + DEPOT)
      DO 200 I = 1, NYRS
        NOB = NBAS(I)
        NOD = NDEP(I)
C
       *CALCULATE NUMBER OF SYSTEMS OPERATING IN YEAR I
C
```

```
NS = NS + NAV*CRFT(I)
       *CALCULATE PEAK FLIGHT AND TOTAL FLIGHT OPERATING HOUPS
C
       *FOR AVIONICS SYSTEMS
\mathbb{C}
        PFAV = 12*PFHR*NS
        TFAV = 12*AFHR*NS
C
\mathbb{C}
      **CALCULATE COST OF INITIAL AND REPLACEMENT SPARES
        DO 60 J = 1, NLRU
          MTBFL = LMTBF(J)
          JRTS = RTS(J)
C
C
         *INVESTMENT LRUS (NONRECURRING)
C
         *DETERMINE IF LRU IS REPAIRABLE OR NON-REPAIRABLE
          IF (ITWL(J) .EQ. 1) 60 TO 10
C
         *REPAIRABLE LRUS
C
          YDUM = TFAV*(FBLRU*JRTS*BMT)/(NOB*MTSFL)
          ZDUM = TFAV*(FBLRU*(1-JRTS)*DMT)/(NOD*HTBFL)
C
          BLRU = AINT(NOB*(YDUM + SUF(2)*SQRT(YDUM)))
          MINLRU = MINB*NOB/LCOML(J)
          IF (BLRU .LT. MINLRU) BLRU = MINLRU
C
          DLRU = AINF(NOD*(ZDUM + SUF(2)*SQRT(ZDUM)))
          MINLRU = MINB*NOD/LCOML(J)
          IF (DLRU .LT. MINLRU) DLRU = MINLRU
C
          NLSPRS = BLRU + DLRU - NSFRL(J)
          GO TO 20
C
         *NON-REPAIRABLE LRUS
C
10
          YDUM = TFAV*FBLRU*BSOBL/(NOB*MTBFL)
          ZDUM = TFAV*FBLRU*BSODL/(NOD*MTBFL)
          TDUM = TFAV*FBLRU*OSBL/MTBFL
          SDUM = TFAV*FBLRU*OSDL/MTBFL
          RDUM = TFAV*ROF/MTBFL
          NLSPRS = AINT(NOB*(YDUM+SUF(2)*SQRT(YDUM)))
                  + AINT(NOD*(ZDUM+SUF(2)*SQRT(ZDUM)))
            + AINT(TDUM) + AINT(SDUM) + AINT(RDUM) - NSPRL(U)
20
          MSPRL(J) = MSPRL(J) + MLSPRS
          NRCOS(I,1) = NRCOS(I,1) + NLSPRS*LUCOS(J)
C
        *REPLENISHMENT LRUS (RECURRING)
C
          RESPRS = AINT(TFAV*COND(J)/MTBFL)
          RLCOS(I_11) = RLCOS(I_11) + RLSPRS*LUCOS(J)*(1 + LMKUF)
```

```
C
        KSRU INITIAL AND REPLACEMENT SPARES
          IF (NSRU(J) .EQ. 0) GO TO 50
          DO 50 K = 1, MSRU(J)
            MTBFS = SMTBF(J,K)
C
           *INVESTMENT SRUS (NONRECURRING)
           *DETERMINE IF SRU(J,K) IS REPAIRABLE OR NON-REPAIRABLE
            IF (ITWS(J,K) .EQ. 1) GO TO 30
C
C
           *REPAIRABLE SRUS
C
            XDUM = TFAV*(FBLRU*JRTS*RTSB(J,K)*BMT)/(NOB*MTBFS)
            YDUM = TFAV*(FBLRU*(JRTS*(1-RTSB(J,K)) + (1-JRTS))**DMT)
              /(NOD*MTBFS)
     1
C
            BSRU=AINT(NOB*(XDUM+SUF(3)*SQRT(XDUM)))
            MINSRU = (XMINB*NOB)/LCOMS(J,K)
            IF (BSRU .LT. MINSRU) BSRU = MINSRU
C
            DSRU = AINT(NOD*(YDUM+SUF(3)*SQRT(YDUH)))
            MINSRU = (XHINB*NOD/LCOMS(J,K))
            IF (DSRU .LT. MINSRU) DSRU = MINSRU
C
            NSSFRS = BSRU + DSRU - NSFRB(J,K)
            GO TO 40
C
           *NON-REPAIRABLE SRUS
C
30
            XDUM=TFAV*FBLRU*JRTS*BSOB/(NOB*MTBFS)
            YDUM = TFAV*FBLRU*(1-JRTS)*BSOD/(NOD*MTBFS)
            WDUM=TFAV*FBLRU*JRTS*OSB/MTBFS
            TDUM = TFAV*FBLRU*(1-JRTS)*OSD/MTBFS
            SDUM=TFAV*ROF/MTBFS
            NSSFRS = AINT(NOB*(XDUM+SUF(3)*SQRT(XDUM)))
              + AINT(NOD*(YDUM+SUF(3)*SQRT(YDUM)))
              + AINT(WDUM) + AINT(TDUM)
     2
              + AINT(SDUM) - NSFRB(J,K)
40
            NSPRB(J,K) = NSPRB(J,K) + NSSPRS
            NRCOS(I,1) = NRCOS(I,1) + NSSPRS*SUCOS(J,K)
           *REPLENISHMENT SRUS (RECURRING)
C
C
            RSSPRS=AINT(TFAV*CONDB(J,K)/MTBFS)
            RLCOS(I,1) = RLCOS(I,1) + RSSPRS*SUCOS(J,K)*(1 + SMKUP)
50
          CONTINUE
60
        CONTINUE
C
      **CALCULATE COSTS OF ON-AIRCRAFT MAINTENANCE
\mathbb{C}
C
       *NONRECURRING COSTS
```

```
*NRCOS(I,2) = 0.0
C
C
       *RECURRING COSTS
C
        DO 70 J = 1, NLRU
          RLCOS(I,2) = RLCOS(I,2) + ((TFAV*RMHB(J)/LMTBF(J))
            + (NS*FPM*PMMH))*BLR
70
        CONTINUE
      **CALCULATE COSTS OF OFF-AIRCRAFT MAINTENANCE
C
C
C
       *NONRECURRING COSTS
C
       *NRCOS(I_73) = 0.0
C
C
       *RECURRING COSTS
C
       *RECURRING OFF-AIRCRAFT MAINTENANCE COSTS ARE COMPOSED OF
C
       *FOUR SUB-COST CATEGORIES: MATERIALS, LABOR, SHIPPING, &
C
       *DOCUMENTATION.
C
       *INITIALIZE DUMMY VARIABLES TO ZERO
        XLMAT = 0.0
        XSMAT = 0.0
        XLREP = 0.0
        XSREP = 0.0
        XLSHP = 0.0
        XSSHP = 0.0
        XLTTR = 0.0
        XSTTR = 0.0
        LRUT = 0.0
        SRUT = 0.0
        BDOC = (ONAC + OFAC + STR)/UMTBF
        DDOC = (OFAC + STR)/UMTBF
C
       *CALCULATE COSTS FOR LRU LEVEL OF MAINTENANCE
С
       *CALCULATE INTERMEDIATE VALUES WITHIN THE LOOPS AND
C
       *THE FINAL VALUES OUTSIDE THE LOOPS
        DO 90 J = 1, NLRU
          JRTS = RTS(J)
          MTBFL = LMTBF(J)
C
C
         *MATERIALS--LRU(J)
C
          XLMAT = XLMAT + ((FBLRU*JRTS*RTLB(J)*BMC(J)) + (FBLRU*JRTS
     1
                  *(1-RTLB(J)) + FBLRU*(1-JRTS))*DMC(J))/MTBFL
C
C
         *LABOR--LRU(J)
C
         XLREP = XLREP + FBLRU*JRTS*LMTTR(J)*(1-ITUL(J))*(RTLB(J)*BLR *
                  (1-RTLB(J))*DLR)/MTBFL
C
C
         *SHIPPING--LRU(J)
```

```
XLSHP = XLSHP + (WT(J)*(FBLRU*((1-JRTS)+JRTS*(1-RTLB(J)))*2
                   *YMIL*SSHC*(1-ITWL(J)) + (FBERU*(1-JRTS)*(YHIL*SSHC+
                  XHIL*SHC)*ITWL(J)))/MTBFL)
         *WEIGHT OF EQUIPMENT SHIPPED TO REPLACE CONDENNED LRU(J)
C
          XLTTR = XLTTR + WT(J)*COND(J)*(1-ITUL(J))/MTBFL
C
C
         *DOCUMENTATION FOR MAINTENANCE--LRU(J)
C
          LRUT = LRUT + (FBLRU*(1-JRTS))/MTBFL
Ü
C
         *CALCULATE COSTS FOR SRU LEVEL OF MAINTENANCE
          IF (NSRU(J) .EQ. 0) GO TO 80
          DO 80 K = 1, NSRU(J)
            XRTSB = RTSB(J*K)
            MTBFS = SMTBF(J,K)
\mathbf{C}
00
           *MATERIALS--SRU(J,K)
            XSMAT = XSMAT + ((FBLRU*JRTS*XRTSB*BMCS(J,K))+(FBLRU*(JRTS
                     *(1-XRTSB)+(1-JRTS))*DMCS(J,K)))/MTBFS
C
C
           *LABOR--SRU(J,K)
C
            XSREP = XSREP + ((FBLRU*JRTS*XRTSB*SMTTR(J,K)*BLR) +
     1
                     (FBLRU*(JRTS*(1-XRTSB)+(1-JRTS))*SMTTR(J,K)*DLR))
     2
                     *(1-ITWS(J,K))/MTBFS
C
C
           *SHIPPING--SRU(J,K)
C
            XSSHP = XSSHP + (WTB(J;K)*((FBLRU*JRTS*(1-XRTSB)*2*YMIL*SSHC
                     *(1-ITWS(J,K))) + (FBLRU*JRTS*(YMIL*SSHC+XMIL*SHC)
                     *ITWS(J,K)))/MTBFS)
C
C,
           *WEIGHT OF EQUIPMENT SHIPPED TO REPLACE CONDEMNED SRU(J.K)
C
            XSTTR = XSTTR + WTB(J,K)*CONDB(J,K)*(1-ITWS(J,K))/MTBFS
C
C
           *DOCUMENTATION FOR MAINTENANCE--SRU(J,K)
C
            SRUT = SRUT + (FBLRU*JRTS*(1-XRTSB))/MTBFS
30
          CONTINUE
90
        CONTINUE
C
C
       *MAKE FINAL CALCULATIONS IN EACH SUB-CATEGORY
C
       *COST OF MATERIALS
C
        TMAT = TFAU*(XLMAT + XSMAT)
C
       *COST OF LABOR
C
```

€.

```
TLABOR = TFAV*(XLREP + XSREP)
O
        *COST OF SHIFFING
C
         TSHIP = PACK*TFAV*((XLTTR + XSTTR)*(YMIL*SSHC + XMIL*SHC)
           + (XLSHP + XSSHP))
C
       *COST OF MAINTENANCE DOCUMENTATION
C
C
        *BASE LEVEL
         BDMTD = (BDOC + (LRUT+SRUT)*TFR)*TFAV*BLR
C
C
       *DEPOT LEVEL
C
        DDMTD = (DDOC + (LRUT+SRUT)*TFR)*TFAV*DLR
C
       *TOTAL OFF-AIRCRAFT MAINTENANCE RECURRING EXPENSE
        RLCOS(I,3) = RLCOS(I,3) + TMAT + TLABOR + TSHIP + BDMTD + DDMTD
C
      **CALCULATE COSTS OF INVENTORY ENTRY AND SUPPLY MANAGEMENT
\mathbf{C}
        NICB = 1
        IF (FRAV .EQ. 0.0) NICB = 0
C
\mathbf{c}
       *NONRECURRING COSTS
C
100
        IF (I .NE. 1) GO TO 110
C
C
       *IF (I \cdotNE \cdot 1) NECOS(I \cdot4) = 0.0
C
        NRCOS(I,4) = NRCOS(I,4) + IAMC*NIC*TIC*NICB
C
\mathbf{c}
       *RECURRING COSTS
C
        RLCOS(1,4) = RLCOS(1,4) + (NOB*NOIB*HOLDB + NOD*NOID*HOLDD
          ) *NICB
        GO TO 115
        RLCOS(I+4) = RLCOS(I+4) + (IAMC*NIC*TIC + NOB*NOIB*HOLDB +
110
     1
                      NOD*NOID*HOLDD)*NICE
C
\mathbf{C}
      **CALCULATE COSTS OF SPECIAL SUPPORT EQUIPMENT
C
       *BASE SUPPORT EQUIPMENT
115
        IF (JSEB .EQ. 0) GO TO 120
        DO 120 L = 1, JSEB
C
\mathbf{C}
         *NONRECURRING COSTS
          XNSEB = AINT(PFAU*BMH(1)*UTILB(L)/(LMTBF(1)*AUALB(L)*BETA);
          YNSER = MINSER*NOR/LCOMB(L)
```

```
IF (NMSEB .LT. YMSEB) XMSEB - YMSEB
          MUSER(I) = NMSER(I) + ((XMSEB-MSER(L)) RUSEIDE (L) -
          MSEB(L) = XNSEB
*RECURRING COSTS
\mathbb{C}
          XRSE8 = PFAUXBMH(1)XUTILS(L)XSECOB3/(L)YBF(1)XAVALB(L)XSETA>
          YRSEB = MSEBO*NSEB(L)
          IF (XRSEB .LT. YRSEB) XRSEB = YRSEB
          PNSEB(I) = PNSEB(I) + XRSEB
        SUMITMOS
1.20
m
       *DEPOT SUPPORT EQUIPMENT
\mathbb{C}
        TF (USED ,EQ. 0) DD TO 130
        00 130 L = 1, JSED
C
()
         *MONRECURRING COSTS
          XNSED = AINT(PFAV*DMH(1)*UTILD(L)/(LMTDF(1)*AVALD(L)*DETA)>
          YNSED = MINSED*NOD/LCOMD(L)
           IF (XNSED .LT. YNSED) XNSED = YMSED
          NNSED(I) = NNSED(I) + ((XNSED-NSED(L))*USECOD(L))
          NSED(L) = XNSED
         *RECURRING COSTS
          XRSED = FFAV*DMH(1)*UTILD(L)*SECOD/(LMTBF(1)*AVALD(L)*DETA)
           YRSED = MSEDO*NSED(L)
           IF (XESED .LT, YESED) XESED = YESED
           RNSED(I) = RNSED(I) + XRSED
130
        CONTINUE
Γ,
\mathbb{C}
       *TOTAL NONRECURRING COST, SPECIAL SUPPORT EQUIPMENT
C
        MRCOS(I,5) = MRCOS(I,5) + MNSEB(I) + MNSED(I)
C
\Gamma_i^*
       *TOTAL RECURRING COST, SPECIAL SUPPORT EQUIPMENT
C
        RLCOS(I.5) = RLCOS(I.5) + RNSEB(I) + RMSED(I)
0
C
      **CALCULATE COST OF TRAINING PERSONNEL
\mathbb{C}
...
       *NONRECURRING COSTS (INITIAL TRAINING)
C
       KBASE LEVEL
C
        XBPER = AINT((TFAV*AMHB/(PMB*PRGDB*UHTBF)))
        YBPER = MINBP*NOB
         IF (XBPER ,LT. YBPER) XBPER = YBPER
        MBPER(I) = MBPER(I) + (XBPER - MPERB)
       *DEPOT LEVEL
```

```
. TPER = AINTO FERAVAAMMD/(PMBAPROTEXUSTER)
        TOPER = MINDPENOU
         IF (KOPER .LT. YDPER) XIPER = YDPER
         MORER(I) = MORER(I) + (XOPER - MPERD)
ľ,
       *TOTAL NONRECURRING
        MRCOS(I)4) = MRCOS(I)4) + MEPER(I)*TODSO + MDPER/I)*TODSD
C
C
        *RECURRING COST / DUE TO PERSONNEL TUPHOVERY
        RLOOS(I)6) = RLOOS(I)6) + NPERB*TOOSB*TRB + MPERB*TCOSD*TRB
         REPER = XBPER
        THEFD = XDPER
\mathcal{O}
\Gamma
0
      **CALCULATE COSTS OF DATA MANAGEMENT AND TECHNICAL DOCUMENTATION
C
i"
       *MONRECURRING COSTS
C
         IF (I ,NE  1) GO TO 135
        MNBAS = NOB
         NADER = MOD
        GO TO 137
135
        NMBAS = NOB - MBAS(I-1)
        MRSEP = NOD - NDEP(I-1)
137
        MRCOS(I,7) = NRCOS(I,7) + OPP*(NPBD*NNBAS + MPDD*NNDEF)
C
i
       *RECURRING COSTS
\mathbf{C}
       *RLCOS(I,7) = 0.0
C
()
\widehat{\Gamma}_{i}
      **CALCULATE COST OF FACILITIES
C
C
        *MONRECURRING COSTS
C
        *NRCOS(I*8) = 0.0
\mathbb{C}
       *RECURRING COSTS
        RLCOS(I,8) = RLCOS(I,8) + FOCB*NOB + FOCD*NOB
C
C
     *TOTAL NONRECURRING AND RECURING LOGISTICS COSTS FOR YEAR I
C
        DC 160 J = 1, 8
           TNRCOS(I) = TNRCOS(I) + NRCOS(I \cdot J)
           TRLCOS(I) = TRLCOS(I) + RLCOS(I,J)
1.60
        CONTINUE
00
       *TOTAL LOGISTIC COSTS FOR YEAR I
        TLLCOS(I) = TNRCOS(I) + TRLCOS(I)
      CONTINUE
200
     *FORMAT STATEMENTS
```

C-18

```
1001
     FORMAT(10X,F8.2,3(7X,F8.2))
1002
     FORMAT(10X,F8.3,7X,F8.3,2(7X,I8))
     FORMAT(10X,18,7X,18,2(7X,F8.2))
1003
1004
     FORMAT(10X,F8.2,7X,18,2(7X,F8.2))
1005
     FGRMAT(10X,F3.2,2(7X,18))
1006
     FORMAT(10X,4(F8.3,7X))
1007
      FORNAT(3X,4(7X,18))
C
      RETURN
      END
```

```
0
                            SUBROUTINE PERGAC
C
C
        THE PERGAC MODULE CALCULATES THE COST PER GA OUNER AND THE COST
C
        PER GENERAL AVIATION AIRCRAFT FOR EACH YEAR IN THE LIFE CYCLE DE
C
          THE SPECIFIED AVIONICS EQUIPMENT.
C
      SUBROUTINE PERGAC(NYRS, DSCNT)
C
\mathbb{C}
     *ESTABLISH COMMON BLOCKS
\mathbf{C}
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRET/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/INSTAL/ICOS(25), TCGSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
                     TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/NAMES/SNAME, UNAME
\mathbf{C}
     *DECLARE VARIABLES
      INTEGER LB, NYRS, UB, YEAR
      REAL ACOS, CLCC, CRFT, ICOS, NAC, NNAC, NRAC, NRCOS
      REAL PEROWN(25), RLCOS, TCOSA, TCOSI, TCOSL, TLCOS, TLLCOS
      REAL THROOS, TRLCOS, NCRFT, PERAC(25)
      LOGICAL*1 SNAME(65), UNAME(35)
C
C
     *INITIALIZE VARIABLES
C
      TLCOS = 0.0
      NCRFT = 0.0
C
      00 10 I = 1, NYRS
C.
0
       *CALCULATE COST FER OWNER OF AVIONICS EQUIPMENT
C
       *NOTE: THE TOTAL LOGISTIC COSTS INCURRED BY THE GA OWNER ARE
C
          RESTRICTED TO RECURRING MAINTENANCE.
C
        NCRFT = NCRFT + CRFT(I)
        PERAC(I) = (TCOSN(I) + TRLCOS(I))/NCRFT
        PEROWN(I) = TRLCOS(I)/NCRFT
10
      CONTINUE
C
C,
     *FRINT RESULTS
\mathbb{C}
      WRITE(6,1005) (SNAME(I), I = 1, 65)
      WRITE(6,1006) (UNAME(I), I = 1, 35)
      WRITE(6:1007) DSCNT
      WRITE(6,1001)
      LB = 1
      UB = 3
      NO = NYRS/UB
      N1 = 1
      N2 = N0
      DO 20 I = LB, UB
```

C-20

```
WRITE(6,1002) (YEAR(J), J = M1 + M2)
        WRITE(6,1004) (PERAC(J), J = N1, N2)
        WRITE(6,1003) (PEROWN(J), J = N1, N2)
        N1 = N1 + N0
        N2 = N2 + N0
        IF (N2 .GT. NYRS) N2 = NYRS
20
      CONTINUE
0
\Gamma_{i}^{*}
     *FORMAT STATEMENTS
C
      FORMAT(1X,//,59X,'AVIONICS COST PER YEAR',/)
1001
1002 FORMAT(1X,//,28X,7(6X,14,5X))
1003 FORMAT(9X, 'COST FER OWNER ', 7(2X, F13.2))
      FORMAT(9X, 'COST PER A/C /, 7(2X, F13, 2))
1004
      FORMAT(1H1+///+4X+'SYSTEM: '+65A1)
1005
1006
      FORMAT(4X, /USER: /,35A1)
1007
      FORMAT(4X, 'DISCOUNT FACTOR: ',F4.2)
      RETURN
      END
```

SUBROUTINE TOTOUM

```
0000
        THE TOTCUM MODULE CALCULATES THE TOTAL LOGISTIC SUPPORT
        COSTS INCURRED EACH YEAR AND THE CUMULATIVE ACQUISITION-
        INSTALLATION, AND LOGISTIC SUPPORT COSTS INCURRED PRIOR TO
        YEAR I.
C
      SUBROUTINE TOTOUM(NYRS)
\epsilon
C
     *ESTABLISH COMMON BLOCKS
      COMMON/ACQUIZ/ACOS(25), (COSA(25)
      COMMON/ARCRET/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25); CPROG(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
                     TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
C
C
     *DECLARE VARIABLES
      INTEGER YEAR
      REAL ICUS, NAC, NRCOS, NRAC
C
C
     *INITIALIZE VARIABLES
      DO 1 I = 1, NYRS
        TCOSA(I) = 0.0
        TCOSI(I) = 0.0
        TCOSN(I) = 0.0
        TCOSR(I) = 0.0
        TCOSL(I) = 0.0
        CPROG(I) = 0.0
1
      CONTINUE
      D0 2 J = 1, 9
        TNRCAT(J) = 0.0
        TRLCAT(J) = 0.0
2
      CONTINUE
      CLCC = 0.0
\mathbb{C}
      DO 30 I = 1, NYRS
        DO 10 J = I, NYRS
O
17
         *DETERMINE CUMULATIVE ACQUISITION COSTS
C
          TCOSA(J) = TCOSA(J) + ACOS(I)
С
C
         *DETERMINE CUMULATIVE INSTALLATION COSTS
C
          TCOSI(J) = TCOSI(J) + ICOS(I)
C
         *DETERMINE CUMULATIVE LOGISTIC SUPPORT COSTS
          TCOSN(J) = TCOSN(J) + TNRCOS(I)
```

```
TCOSR(J) = TCOSR(J) + TRLCOS(I)
          TCOSL(J) = TCOSL(J) + TLLCOS(I)
C
Ö
         *DETERMINE CUMULATIVE PROGRAM COSTS
          CPROG(J) = CPROG(J) + ACOS(I) + ICOS(I) + TLLCOS(I)
10
        CONTINUE
C
C
       *DETERMINE TOTAL PROGRAM COST FOR YEAR I
Ü
        TFROG(I) = TLLCOS(I) + ACOS(I) + ICOS(I)
C
\mathbb{C}
       *DETERMINE CUMULATIVE PROGRAM COST
C
        CLCC = CLCC + TPROG(I)
C
       *DETERMINE TOTAL FOR EACH LOGISTIC CATEGORY
        DO 20 J = 1, 8
          TNRCAT(J) = TNRCAT(J) + NRCOS(I+J)
          TNRCAT(9) = TNRCAT(9) + NRCOS(I,J)
          TRLCAT(J) = TRLCAT(J) + RLCOS(I,J)
          TRLCAT(9) = TRLCAT(9) + RLCOS(I,J)
20
        CONTINUE
30
      CONTINUE
      RETURN
      END
```

```
SUBROUTINE OUTTAB
0
        THE OUTTAB MODULE OUTPUTS ALL OF THE VALUES COMPUTED IN
C
        THE LIFE CYCLE COSTING MODEL IN TABULAR FORM.
O
C
      SUBROUTINE OUTTAB(NYRS,DSCNT)
C
     *ESTABLISH COMMON BLOCKS
\mathbf{C}
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRET/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25), CPROG(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
                     TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/NAMES/SNAME, UNAME
C
     *DECLARE VARIABLES
C
      INTEGER YEAR, UB
      REAL ICOS, NRAC, NAC, NRCOS
      LOGICAL*1 ANS, SNAME(45), UNAME(35)
C
      *INITIALIZE VARIABLES
C
       NO = NYRS/3
      LF = 1
       UB = 2
\mathbb{C}
      WRITE(1,*) 'DO YOU WANT A NONRECURRING/RECURRING COST BREAKDOWN?'
       READ(1,1050) ANS
       IF (ANS .NE. 'Y') GO TO 27
      *FRINT HEADINGS, INVESTMENT COSTS
C
       WRITE(6,1034) (SNAME(I), I = 1,65)
       WRITE(6,1035) (UNAME(I), I = 1,35)
       WRITE(6,1036) DSCNT
       WRITE(6,1000)
       ਮੋ1 = 1
       N2 = N0
      *FRINT NONRECURRING COSTS FOR EACH YEAR BY CATEGORY
 \mathbf{C}
       DO 10 I = LB, UB
         WRITE(6,1001) (YEAR(J), J = N1, N2)
         WRITE(6,1002) (NRCOS(J,1), J = N1, N2)
         WRITE(6,1005) (NRCOS(J,4), J = N1, N2)
         WRITE(6,1006) (NRCOS(J,5), J = N1, N2)
         WRITE(6,1007) (NRCOS(J,6), J = N1, N2)
         WRITE(6,1008) (NRCOS(J,7), J = N1, N2)
         WRITE(6,1009) (NRCOS(J,8), J = N1, N2)
```

WRITE(6,1010) (THRCOS(J), J = N1, N2)

N1 = N1 + N0

```
M2 = M2 + M0
        IF (N2 .LT. NYRS) GO TO 10
        N2 = NYRS
        GO TO 15
1.0
      CONTINUE
15
      \mathsf{URITE}(A, 102A) \quad (\mathsf{YEAR}(\mathsf{J}), \mathsf{J} = \mathsf{N1}, \; \mathsf{N2})
      WRITE(6,1027)
      WRITE(6,1012) (NRCOS(J,1), J = N1, N2)
      WRITE(3,1013) THRCAT(1)
      WRITE(6,1016) (NRCOS(J,4), J = N1, N2)
      WRITE(6,1013) TNRCAT(4)
      WRITE(6,1017) (NRCOS(J,5), J = N1, N2)
      WRITE(6,1013) TNRCAT(5)
      \mathsf{URITE}(6,1018) (NRCOS(J,6), J = N1, N2)
      WRITE(1,1013) TNRCAT(6)
      WRITE(6,1019) (NRCOS(J,7), J = N1, N2)
      WRITE(6,1013) TNRCAT(7)
      WRITE(6,1020) (NRCOS(J,8), J = N1, N2)
      WRITE(6,1013) TNRCAT(8)
      WRITE(6,1021) (TNRCOS(J), J = N1, N2)
      WRITE(6,1013) TNRCAT(9)
C
\mathbf{C}
     *FRINT HEADINGS, OPERATING AND SUPPORT COSTS
      WRITE(6,1034) (SNAME(I), I = 1, 65)
      WRITE(6,1035) (UNAME(I), I = 1, 35)
      WRITE(6,1036) DSCNT
      WRITE(6,1028)
      N1 = 1
      N2 = N0
     *PRINT RECURRING COSTS FOR EACH CATEGORY BY YEAR
C
      DO 20 I = LB, UB
        WRITE(6,1001) (YEAR(J), J \approx N1, N2)
        WRITE(6,1002) (RLCOS(J,1), J = N1, N2)
        WRITE(6,1003) (RLCOS(J,2), J = N1, N2)
        WRITE(6,1004) (RLCOS(J,3), J = N1, N2)
        WRITE(6:1005) (RLCOS(J,4), J = N1, N2)
        WRITE(5,1006) (RLCOS(J,5), J = N1, N2)
        WRITE(6,1007) (RLCOS(J,6), J = N1, N2)
        WRITE(6,1008) (RLCOS(J,7), J = N1, N2)
        \forall RITE(6,1009) (RLCOS(J,8), J = N1, N2)
        WRITE(6,1010) (TRLCOS(J), J = N1, N2)
        N1 = N1 + N0
        N2 = N2 + N0
        IF (N2 .LT. NYRS) GO TO 20
        N2 = NYRS
        GO TO 25
20
      CONTINUE
25
      WRITE(6,1026) (YEAR(J), J = N1, N2)
```

```
WRITE(6,1027)
      WRITE(6,1012) (RLCOS(J,1), J = N1, N2)
      WRITE(6,1013) TRLCAT(1)
      WRITE(6,1014) (RLCOS(J,2), J = N1, N2)
      WRITE(6,1013) TRLCAT(2)
      WRITE(6,1015) (RLCOS(J,3), J = N1, N2)
      WRITE(6,1013) TRLCAT(3)
      WRITE(6,1016) (RLCOS(J,4), J = N1, N2)
      WRITE(6,1013) TRLCAT(4)
      WRITE(6,1017) (RLCOS(J,5), J = N1, N2)
      WRITE(6,1013) TELCAT(5)
      WRITE(6,1018) (RLCOS(J,6), J = N1, N2)
      WRITE(6,1013) TRLCAT(6)
      WRITE(6,1019) (RLCOS(J,7), J = N1, N2)
      WRITE(6,1013) TRLCAT(7)
      WRITE(6.1020) (RLCOS(J.8), J = N1, N2)
      WRITE(6,1013) TRLCAT(8)
      WRITE(6,1021) (TRLCOS(J), J = N1, N2)
      WRITE(6,1013) TRUCAT(9)
\mathbb{C}
     *FRINT HEADINGS FOR TOTAL LIFE CYCLE COSTS BY YEAR
C
27
      WRITE(6,1034) (SNAME(1), I = 1, 65)
      WRITE(6,1035) (GWARE(I), I = 1, 35)
      WRITE(6,103a) DSCAT
      WRITE(6,1029)
      N1 = 1
      N2 = N0
C
     *PRINT RESULTS
      DO 30 I = LB, UB
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1030) (ACDS(J), J = N1, N2)
        WRITE(6,1031) (ICOS(J), J = N1, N2)
        WRITE(6,1037) (TNRCOS(J), J = N1, N2)
        WRITE(6,1038) (TRLCOS(J), J = N1, N2)
        WRITE(6,1032) (TLLCOS(J), J = N1, N2)
        WRITE(6,1033) (TPROG(J), J = N1, N2)
        N1 = N1 + N0
        N2 = N2 + N0
        IF (N2 .LT. NYRS) GO TO 30
        N2 = NYRS
        GO TO 35
30
      CONTINUE
35
      VRITE(6,1026) (YEAR(J), J = N1, N2)
      WRITE(6,1027)
      WRITE(6,1022) (ACOS(J), J = N1, N2)
      WRITE(6,1013) TCOSA(NYRS)
      WRITE(6,1023) (ICOS(J), J = N1, N2)
      WRITE(6,1013) TCOSI(NYRS)
      WRITE(5,1040) (TNRCOS(J), J = N1, N2)
      WRITE(6,1013) TOOSN(NYRS)
```

```
WRITE(6,1041) (TRLCOS(J), J = N1, N2)
      WRITE(6,1013) TCOSR(NYRS)
      WRITE(6,1024) (TLLCOS(J), J = N1, N2)
      WRITE(6,1013) TOOSL(NYRS)
      WRITE(4,1025) (TPROG(J), J = N1, N2)
      WRITE(6,1013) CLCC
\mathbf{c}
C
     *PRINT HEADINGS FOR CUMULATIVE LIFE CYCLE COSTS BY YEAR
C
      WRITE(6,1039)
      N1 = 1
      N2 = N0
C
\mathbf{C}
     *FRINT RESULTS
      BO 40 I = LB, UB+1
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1030) (TCOSA(J), J = N1, N2)
        WRITE(6,1031) (TCOSI(J), J = N1, N2)
        WRITE(6,1037) (TCOSN(J), J = N1, N2)
        WRITE(6,1038) (TCOSR(J), J = N1, N2)
        WRITE(6,1032) (TCOSL(J), J = N1, N2)
        MRITE(6,1033) (CPROG(J), J = N1, N2)
        N1 = N1 + N0
        N2 = N2 + N0
        IF (N2 .LT. NYRS) GO TO 40
        N2 = NYRS
40
      CONTINUE
     XFORMAT STATEMENTS
C.
C,
      FORMAT(49%,'NONRECURRING LOGISTIC SUPPORT COSTS',//>
1,000
      FORMAT(1X,//,9X,'COST CATEGORY ', 2X, 7(6X,14,5X),/)
1001
                                  /, 8(2X,F13,0))
1002
      FORMAT(9X, 'SPARES
                                  /, 8(2X,F13.0))
1003
      FORMAT(9X, 'ON-A/C MAINT
1004
      FORMAT(9X,'OFF-A/C MAINT
                                  /, 8(2X,F13.0))
      FORMAT(9X, 'INVENTORY MGT
                                  ', 8(2X,F13.0))
1005
      FORMAT(9X, 'SUPPORT EQUIP
                                  /, 8(2X,F13.0))
1006
                                  ', 8(2X,F13.0))
      FORMAT(9X) TRAINING
1007
1008
      FORMAT(9X, 'DATA MANAGEMENT', 8(2X, F13.0))
1009
      FORMAT(9X, 'FACILITIES
                                  /, 8(2X,F13.0))
      FORMAT(9X, 'ANNUAL TOTAL
                                  /, 8(2X,F13.0))
1010
1012
      FORMAT('$',8X,'SPARES
                                      /,8(2X,F13,0))
      FORMAT((+/,2X,F13.0)
1013
      FORMAT('$',8X,'ON-A/C MAINT
                                      ',8(2X,F13.0))
1014
      FORMAT('$',8X,'OFF-A/C MAINT
                                      /,8(2X,F13.0))
1015
      FORMAT('$',8X,'INVENTORY MGT
                                      /,8(2X,F13,0))
1016
      FORMAT('$',8X,'SUPPORT EQUIP
1017
                                      1,8(2X,F13.0))
      FORMAT('$',8X,'TRAINING
                                      /,8(2X,F13.0))
1013
      FORMAT('$',8X,'DATA MANAGEMENT',8(2X,F13,0))
1019
1020
      FORMAT(/#/,8X,/FACILITIES
                                      /,8(2X,F13,0))
                                      (,8(2X,F13.0))
1021
      FORMAT('$',8X,'ANNUAL TOTAL
      FORMAT('$',8X,'ACQUISITION
                                      /,8(2X,F13.0))
1022
```

```
FORMAT('$',8X,'INSTALLATION ',8(2X,F13,0))
1023
     FORMAT(($1,8X,'TOTAL LOGISTIC (,8(2X,F13,0))
1024
      FORMAT(/$/,8X,/TOTAL PROGRAM /,8(2X,F13,0))
1025
      FORMAT(1X,//,/$/,8X,/COST CATEGORY /,2X,7(6X,14,5X))
1026
      FORMAT('+',2X,'TOTAL')
1027
      FORMAT(52X, 'RECURRING LOGISTIC SUPPORT COSTS',//)
1028
      FORMAT(56X, 'TOTAL LIFE CYCLE COSTS BY YEAR')
1029
                                7,8(2X,F13,0))
      FORMAT(9X, 'ACQUISITION
1030
                               ',8(2X,F13,0))
      FORMAT(9X, 'INSTALLATION
1031
      FORMAT(9X, TOTAL LOGISTIC (,8(2X, F13.0))
1032
     FORMAT(9X, 'TOTAL PROGRAM (,8(2X,F13.0))
1033
      FORMAT(1H1,3X,'SYSTEM: ',65A1)
1034
      FORMAT(4X) (USER: (+35A1)
1035
     FORMAT(4X+'DISCOUNT FACTOR:',F4.2)
1036
      FORMAT(9X, 'NONRECURRING ',8(2X,F13,0))
1037
                                ',8(2X,F13.0))
1038 FORMAT(9X, 'RECURRING
      FORMAT(1X,//,50X, CUMULATIVE LIFE CYCLE COSTS BY YEAR')
1039
      FORMAT('$',8X,'NONRECURRING ',8(2X,F13.0))
1040
                                    7,8(2X,F13,0))
      FORMAT('$',8X,'RECURRING
1041
      FORMAT(10A1)
1050
      RETURN
      END
```

END

APPENDIX D

LIFE-CYCLE-COST MODEL PARAMETER SUMMARY

DESCRIPTION	VALUE
	DESCRIPTION

AFHR	Average flight hours per month per A/C	15.8 hrs.
AMCOS	Amortization cost	0 (100k per LSI)
AVALB,	Availability of Lth type base support equipment	1
AVALD	Availability of Lth type depot support equipment	7
BETA	Base support equipment time available per month (hrs)	160 hrs.
BIT	Fraction of failures isolated to LRU by Built-In Test Equipment	0
BLR	Base labor rate (\$/hr)	\$25.25/hr.
ВИС	Average base materials cost per maintenance action on Jth LRU	System Variable
BMCS _{J,K}	Average base materials cost per maintenance action on Kth SRU in Jth LRU	System Variable
BMH	Average labor-hours to isolate $\mathtt{LRU}_\mathtt{J}$ failure to SRU level base	System Variable
BMAS	Average labor-hours to isolate failure to LRU, base	0.5
BMT	Average base turnaround time (mo.)	0.033
BSOB	Base SRU stocking objective (mo.)	N/A
BSCBL	Base LRU stocking objective (mo.)	N/A
BSOD	Depot SRU stocking objective (mo.)	N/A
BSODL	Depot LRU stocking objective (mo.)	N/A
COMD	Fraction LRU failures resulting in condemnations	System Variable
CONDBJ,K	Fraction SRU $_{ m J,K}$ failures resulting in condemnations	System Variable

NOTE: "Base" represents any FAA certified avionics repair facility. "Depot" represents any DABS manufacturer

	VARIABLE	DESCRIPTION	VALUE
	gen Gran	Cost per page, original technical documentation	N/A
	DETA	Depot support equipment time available per month (hrs)	160 hrs.
	DIST	Percentage mark-up by distributors on full unit	09.0
	DLR	Depot labor rate	\$27.76/hr.
	DMCJ	Average depot materials cost per maintenance action on Jth LRU	System Variable
	DMCS J, K	Average depot materials cost per maintenance action on Kth SRU	System Variable
	рмн _Ј		System Variable
	DMHS	Average labor-hours to isolate failure to LRU level, depot	0.25
	DMT	Depot turnaround time (mo.)	.268 то.
D-4	FOCB	Annual base facilities cost attributable to system being analyzed	N/A
	FOCD	Annual depot facilities cost attributable to system being analyzed	N/A
	FPM	Annual frequency of preventive maintenance	N/A
	FRAV	Fraction of A/C in user category having specified avionics	1.0
	FUCOS	Average sell price less amortization of avionics unit	System Variable
	ногрв	Average annual holding cost per item type, base	N/A
	ОСТОР	Average annual holding cost per item type, depot	N/A
	IAMC	Cost of introducing each new inventory coded item	N/A
	INCOS	Installation cost of avionics in new A/C	\$195
	ITWL	Repair/throw-away flag for Jth LRU	System Variable
	JSEB	Number of differate types of base support equipment	System Variable

	NESCRIPTION	VALUE
VARIABLE	-	System Variable
JSED	Number of different types or defor were	-
LCOMBL	Number avionics unit types to which Lth type base support equipment is common	.
TCOMD	Number avionics unit types to which Lth type depot support equipment is common	.
LCOML	Number avionics unit types to which Jth LRU is common	н
LCOMS	Number avionics unit type to which $\mathrm{SRU}_{\mathrm{J,K}}$ is common	н
T.D.T.S.T.	Percentage mark-up by distributors on LRUs	0.0
IMTBF	Mean time between failures (MTBF) of Jth LRU	System Variable
D	were time to repair LRU.	System Variable
LATTR	Medi time to terms 3	System Variable
LUCOS	Unit cost of Jth LRU	-
MINSEB	Minimum number support equipment sets per type per base	4
MINSED	Minimum number support equipment sets per type per depot	-
MSEBO	Minimum annual support equipment operating cost, base	N/A
MSEDO	Minimum annual support equipment operating cost, depot	A/A
NAV	Average number avionics units per A/C	- 1
NIC	Fraction of inventory coded items that are new	W/W
NLRU	Number LRUs per avionics unit	7
NNACT	Number of new A/C in user category in year I	12,850
NNB	Number new bases added each year	ÇÎ G
ONN	Number new depots added each year	Þ

VARIABLE	DESCRIPTION	VALUE
NOBAS	Number of bases in first year of life cycle	90
NODEP	Number of depots in first year of life cycle	80
NOIB	Number different item types stocked at base	N/A
NOID	Number different item types stocked at depot	N/A
NPBD	Number pages base level documentation	N/A
MPDD	Number pages depot level documentation	N/A
NSRUJ	Number of SRUs in Jth LRU	System Variable
NUM	Number of systems to be evaluated in program run (user input)	1
NYRS	Number years in life cycle	15
OFAC	Average time to complete off-A/C maintenance records	.24 hrs.
ONAC	Average time to complete on A/C maintenance records	N/A
OSB	Average SRU order/ship time, base (mo.)	.134
OSBL	Average LRU order/ship time, base (mo.)	.134
OSD	Average SRU order/ship time, depot (mo.)	N/A
OSDL	Average order/ship time, LRU, depot (mo.)	N/A
PACK	Packaging factor (packed wt/unpacked wt.)	1.125
PFHR	Peak flight hours per month per A/C	18.9 hrs.
PMB	Available hours per year per man, base	2080
PMD	Available hours per year per man, depot	2080

VARIABLE	DESCRIPTION	VALUE
PMMH	Average labor-hours per preventive maintenance action	N/A
PQTY	Production lot size per manufacturer per year	3500
PRODB	Productivity of base repair personnel	. 86
PRODE	Productivity of depot repair personnel	. 86
RICOS	Retrofit cost of avionics	\$264.
RMHBJ	Average labor-hours to remove and replace LRU $_{f J}$, base	System Variable
ROP	Requirements objectives period	N/A
RTLBJ	Fraction LRU $_{ m J}$ failures repaired at base	1.0
RTS	Fraction LRU, failures isolated to SRU at base	System Variable
RTSB J, K	Fraction repairable SRU $_{ m J,K}$ repaired at base	System Variable
RTSS	Fraction of failures isolated to LRU at base	1.0
SDIST	Percentage markup by distributors on SRUs	0.35
SECOB	Support equipment operating cost, base	N/A
SECOD	Support equipment operating cost, depot	N/A
SHC	Shipping rate, first destination (\$/lbzone)	\$1.37
SMTBF J, K	MTBF of Kth SRU in Jth LRU	System Variable
SHTR _{J, K}	Mean time to repair $SRU_{J,K}$	System Variable
SSHC	Shipping rate between base and depot $(\$/lbzone)$	\$1.37
STR	Average time to complete supply transaction records	.25 hrs.
sucos _{J,K}	Unit cost of SRU J,K	System Variable

91911	DESCRIPTION	VALUE
SIIP (2)	LRU spares sufficiency factor	. 50
(5) (5)	SRU spares sufficiency factor	.50
SOF (3)	Training cost per base repair person	N/A
TCOSD .	cost	N/A
TFR		.16 hrs.
TIC	Total number of inventory coded items in stock	N/A
TNRAC	Number A/C to be retrofit in user category, year I	14896
TRB	Personnel turnover rate, base	N/A
TRD	Personnel turnover rate, depot	N/A
UMTBE	MTBF of avionics unit	System Variable
USECOB	Unit cost of Lth type base support equipment	System Variable
USECOD,	Unit cost of Lth type depot support equipment	System Variable
utilb.	Utilization rate, Lth type base support equipment	System Variable
UTILD	Utilization rate, Lth type depot support equipment	System Variable
MT.	Weight of Jth LRU (1b.)	System Variable
WTB	Weight of Kth SRU in Jth LRU (lb.)	System Variable
XOIS	Discount rate	.10
XMIL	Average number of shipping zones to first destination	N/A
XMINB	Minimum number each type SRU spares per base	1
XLRN	Learning curve factor	.875

DESCRIPTION	Minimum number base repair personnel	Minimum number depot repair personnel	Minimum number each type LRU spare per base	Average number of shipping zones between base and depot
	number	number	number	number
	Minimum r	Minimum 1	Minimum 1	Average
VARIABLE	XMINBP	XMINDP	XMINIB	YMIL

APPENDIX E

DISCRETE ADDRESS BEACON SYSTEM TRANSPONDER LOGIC DESIGNS

1.0	BASELINE DABS WITH COMM A AND COMM B	E-3
2.0	ATARS	E-32
3.0	EXTENDED LENGTH MESSAGES	E-39

APPENDIX E

DISCRETE ADDRESS BEACON SYSTEM TRANSPONDER LOGIC DESIGNS

1.0 BASELINE DABS WITH COMM A AND COMM B

The baseline DABS transponder was designed to meet minimum surveillance criteria. This transponder would have the same capability as the present ATCRBS transponder, but additionally, it would be able to respond to BCAS surveillance interrogations (Uplink Formats 0 and 2), the DABS All-Call interrogation (Uplink Format 11), an altitude interrogation (Uplink Format 4), and an identification interrogation (Uplink Format 5). The baseline DABS transponder would also have the capability of generating unsolicited replies (squitters) which are necessary for BCAS purposes. Expansion of the baseline DABS transponder data field to 112 bits provides an additional 56 bits of data for various communication functions while performing all of the surveillance-associated functions of the baseline design. The expansion to include 56 additional bits (Comm A and Comm B capability) affects only the encode/decode design of the transponder and the power supply capacity.

The circuitry described in the following sections covers the logic elements necessary to decode an interrogation and to generate a response. It does not cover the radio frequency circuitry necessary for full transponder operation. Since the changes in DABS brought about by the new standard are mostly in the realm of data processing and manipulation, it is this area that is discussed in the following sections.

1.1 Transponder Capability

The basic DABS transponder has been designed to detect interrogations and respond as follows:

Interrogation:	kesponse:
ATCRBS (ALL)	ATCRBS (ALL)
ATCRBS/DABS All-Call	DABS All-Call (DF11)
ATCRBS Only All-Call	None
DABS Short Special Surveillance (UFO)	DABS Reply (DFO)

DABS Short Synchronous Surveillance (UF2)

DABS Reply (DF2)

Interrogation:

DABS Only All-Call (UF11)

DABS Altitude (UF4)

DABS Identity (UF5)

All Other DABS

Response:

DABS-Only All-Call (DF11)

DABS Altitude (DF4)

DABS Identity (DF5)

None

UF - Uplink Format

DF - Downlink Format

In addition to the above, unsolicited responses (squitters) are emitted at a mean interval time of 1 second; the DABS Altitude response (DF4) is used.

All of the ATCRBS functions have been preserved.

1.2 Basic System Modules

The baseline DABS transponder consists of the following modules:

- . Front and Back Panel Interface
- . System Clocking/Timing
- . Pulse Decoding
- . Arbiter Chip
- . ATCRBS Reply Formatting
- . Squitter Emission
- . DABS Parity Check/Generation
- . Stochastic Acquisition (Probability of Reply)
- . Data Field Definitions
- . DABS Reply Formatting
- . All Call Lockout
- . Comm A and Comm B

The modules are described in the following sections.

1.3 Back and Front Panel Interface

A data input connector is supplied on the back panel of the transponder. A jumper to ground on any pin results in that input being a "l". No jumper is understood as a "0". Therefore, no jumper connection results in a zero in the appropriate field which is interpreted as a "no capability" and "no discrete address".

There are thirty-nine inputs on the back panel. As shown in Figure E-1, twenty-four inputs are associated with the discrete address of the aircraft. Three inputs are associated with the capability of the aircraft. Three inputs are for the maximum airspeed input which is used in response to a BCAS interrogation. Another nine inputs, as shown in Figure E-2, are for the encoding altimeter; with none connected, the field is set to zero.

Figure E-3 illustrates the circuit for the front panel interface. The Function Selector Switch implements the same functions as those found on any ATCRBS transponder. The standby position applies power to all portions of the transponder. However, the ATCRBS logic is inhibited such that no responses are generated. The DABS logic is not inhibited, but rather reflects the "on-the-ground" condition in the flight status field. The Mode A (only) position enables the logic circuitry to respond to interrogations; if an interrogation requires an altitude report, then the altitude field is zero. This allows the pilot to inhibit the input from an encoding altimeter. The Mode A/Mode C position enables the full functions of the transponder, allowing the input of the altitude encoder. The test position turns all panel lamps on (e.g., ATCRBS, DABS, and IDENT).

The IDENT switch is a momentary contact pushbutton which triggers a 16-second timing circuit. Any ATCRBS interrogations within this time will produce a response containing a SPI pulse which will fill in beacon slashes on the air traffic controllers radar display. The SPI pulse will also cause the pushbutton to light.

Whenever a DABS or an ATCRBS response is made to a correctly received interrogation, an appropriate 16-second timer is triggered which enables a panel lamp. Whenever a DABS and/or ATCRBS panel light is on, the pilot has been alerted that a response has been made by the transponder at some point during the past 16 seconds. An automatic dimmer control is provided to adjust brightness.

The pilot may assign a four digit (4096) code to the aircraft through four switches on the front panel. This code is digitized into thirteen bits of information (which includes a "x" bit reserved for future use).

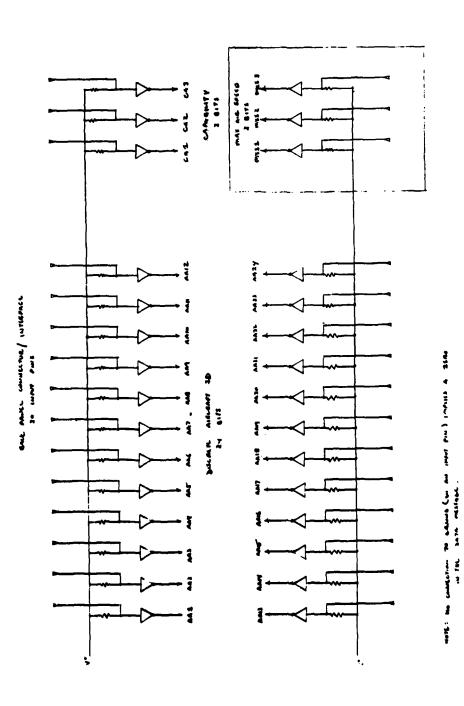


Figure E-1. BACK PANEL CONNECTOR/INTERFACE

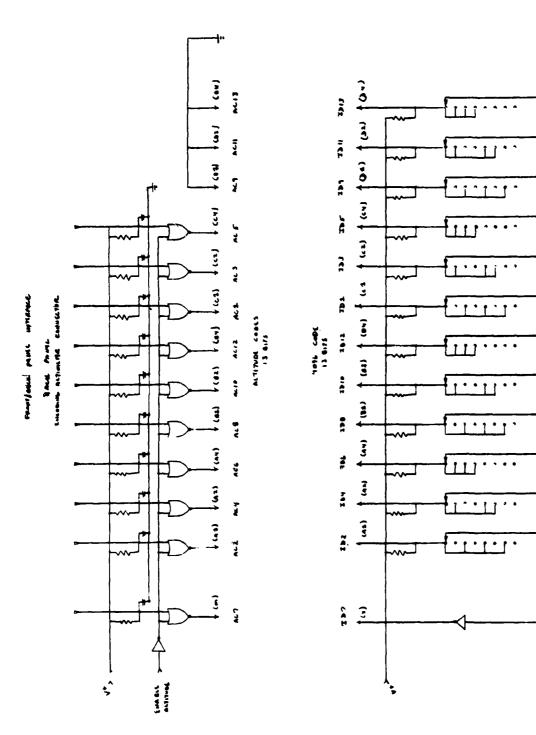


Figure E-2. BACK/FRONT PANEL INTERFACE

Figure E-3. FRONT PANEL INTERFACE

1.4 System Clocking/Timing

When power is applied to the transponder, a timing circuit produces a low level which sets all memory elements to zero (e.g., counters, flip flops, shift registers). The transition moves from a low to a high level 1 millisecond later and all circuits are then ready for operation (subject to the position of the Function Selector Switch).

A 24 MHz oscillator is ultilized to drive the digital logic into synchronization with the "P" pulse. This frequency was chosen so that one clock could be divided to supply the other clocks necessary for the logic, while at the same time avoiding possible harmonics which could interfere with the 60 MHz IF amplifier. A 20 MHz frequency would have been desireable because simple integer division would produce all of the clock frequencies necessary for the digital logic (i.e., division of 20 MHz by 5, 20, and 29 will produce frequencies of 4 MHz, 1 MHz and 689.7 KHz) however, harmonics of the 20 MHz frequency fall within the IF band.

The 24 MHz clock is divided by 6 to produce a 4 MHz clock and by 24 to produce a 1 MHz clock; these clocks control all DABS processing. The processing necessary to generate an ATCRBS response requires a 690 KHz clock (1.45 microsecond period). Dividing the 24 MHz by a constant number to obtain a fixed period between pulses will cause the cumulative error over the course of the ATCRBS transmission to exceed the ± 100 nanosecond tolerance for the starting edge of the last pulse (SPI pulse). The procedure we implemented involves generating a sequence of pulses separated by varying periods to compensate for the cumulative error. These periods are generated by dividing the 24 MHz clock by 35, 35, 35, and 34. This pattern is repeated for the duration of the ATCRBS transmission, assuring that no pulse is generated which is more than 33.2 nanoseconds off the required spacing; this is well within the ± 100 nanosecond criterion.

Drawings of these circuits are not included in the appendix.

1.5 Pulse Decoding

Pulse Decoding implementation uses a counting technique to interpret the pulse combinations which are received. When a pulse (interpreted as a Pl pulse) arrives as Buffered Video input (that is, after it has been processed for amplitude and width criteria) as shown in Figure E-4, it triggers a binary counter. This counter provides an address to a Read-Only Memory (ROM) which then generates certain timing signals for further processing. Each counter value represents a certain time increment after the leading edge of the Pl pulse.

The Buffered Video Input is fed into shift registers operating at 24 MHz. The content of the registers is examined (by Pulse Detect B) to detect a Pl pulse, this occurance triggers a JK flip flop which enables a 10-bit binary counter. The ten output lines of the counter drive a ROM which generates additional timing signals. Whenever a pulse could occur, a timing signal is generated to detect its presence or absence. Spaces are checked at certain intervals to eliminate cases of false triggering. The pulse decoding timing diagram is shown in Figure E-5.

The various pulse combinations which are known to be valid, trigger flip flops which instruct subsequent logic to prepare a proper response. When an incorrect pulse combination is detected, a reset pulse is generated so that the control counter and all memory elements are prepared to receive the next incoming pulse. A reset pulse is also generated if an ATCRBS-only interrogation is received or if other DABS messages are received which the transponder is designed to ignore.

1.6 Arbiter Circuit

There are three types of transmissions which can be made by the transponder. An interrogation can produce an ATCRBS reply, a DABS reply, or an unsolicited reply (squitter) for BCAS purposes. A circuit has been included to decide which response will be made at a given moment. The Arbiter Circuit, shown in Figure E-6, utilizes a polling technique to select what type of processing should occur next. A free-running, two-bit binary counter (which drives a multiplexing unit) samples the three request lines. The first request for a transmission (i.e., the first sampled line which is high) sets a flip-flop;

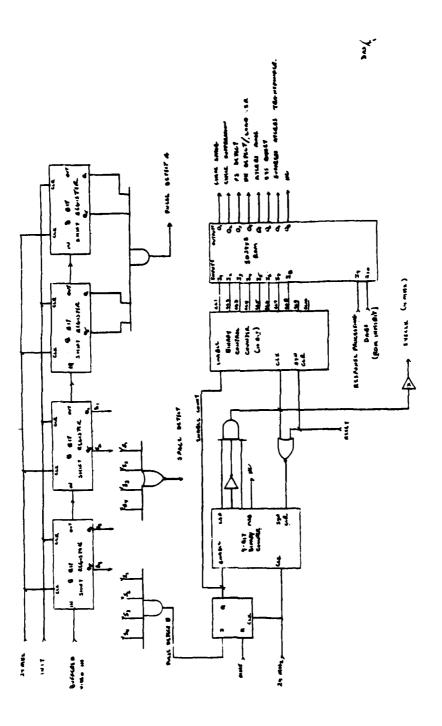


Figure E-4. PULSE DECODING LOGIC

A STATE OF S

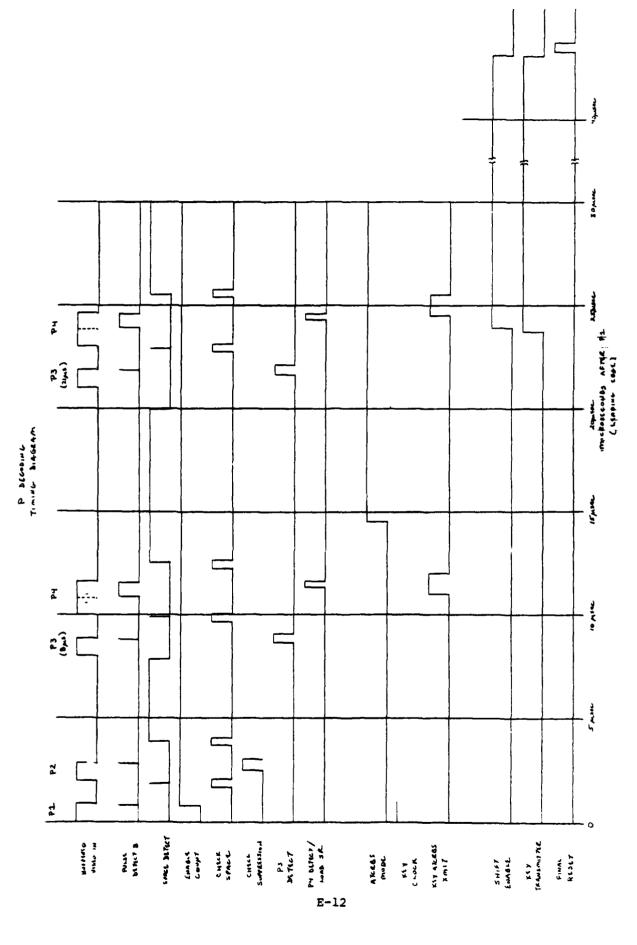


Figure E-5. PULSE DECODING TIMING DIAGRAM

this indicates to other subsequent logic that a message is being processed and locks out the polling process until the message processing is complete (when the reset pulse occurs). The request for a transmission also sets a flipflop at the time prompted by a control signal from the baseline transponder logic. For example, an ATCRBS request will set a flip-flop (which generates the ATCRBS Enable control signal to allow further processing) when activated by the GO ATCRBS signal from the baseline transponder control logic. This procedure is identical to that which is used with a DABS request. The squitter request process is slightly different in that it automatically sets a flip-flop to generate the Squitter Enable signal. In this case, when the DABS system is reset, the flip-flop is cleared along with resetting the squitter timing logic.

1.7 ATCRBS Reply Formatting

The main logic circuit determines the presence of a valid ATCRBS interrogation. If a suppression pulse (P2) is detected, then the circuitry is reset and the interrogation is ignored. However, if a valid interrogation is detected with no suppression, then a valid response is formulated. Figure E-7 illustrates the ATCRBS Reply control logic while the ATCRBS reply formatting is shown in Figure E-8.

A free-running oscillator at 2.76 MHz drives the circuit. When an ATCRBS enable pulse is detected, a counter is enabled; this counter drives a ROM which generates timing information. The counter divides the clock pulses by four, clocking all operations (except the ROM) at 690 KHz.

The ROM loads the shift register. The message is either formatted with ID information (mode A) or altitude information (mode C). If a P3 pulse is detected, the output of an encoding altimeter is loaded into a shift register. When ID information is required, it is entered via a set of switches on the front panel (the 4096 code). The SPI pulse can be activated to flash an indicator on the air traffic controller's radar screen. If the ground requests that the pilot squalk his identify, the pilot presses a panel button which loads the SPI pulses into the shift register upon the receipt of the next ATCRBS interrogation.

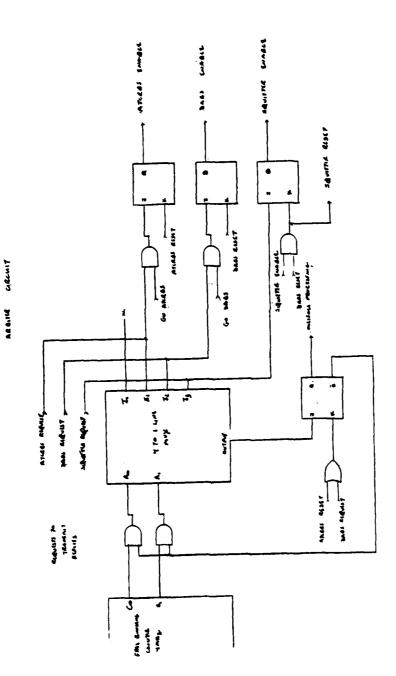
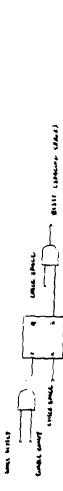


Figure E-6, ARBITER CIRCUIT

And the second s



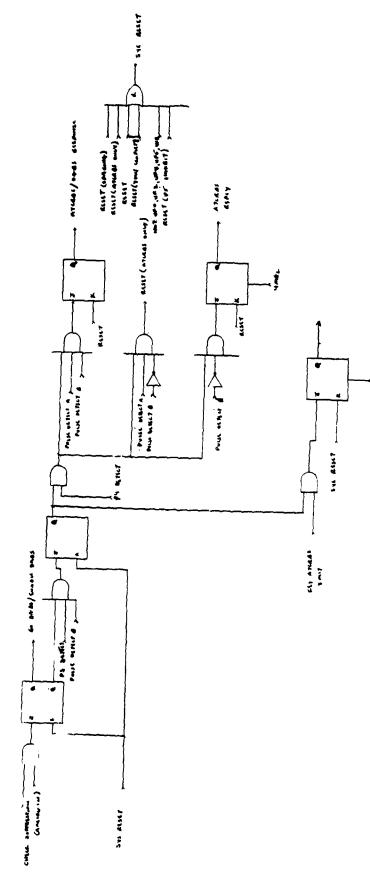


Figure E-7. ATCRBS REPLY CONTROL LOGIC

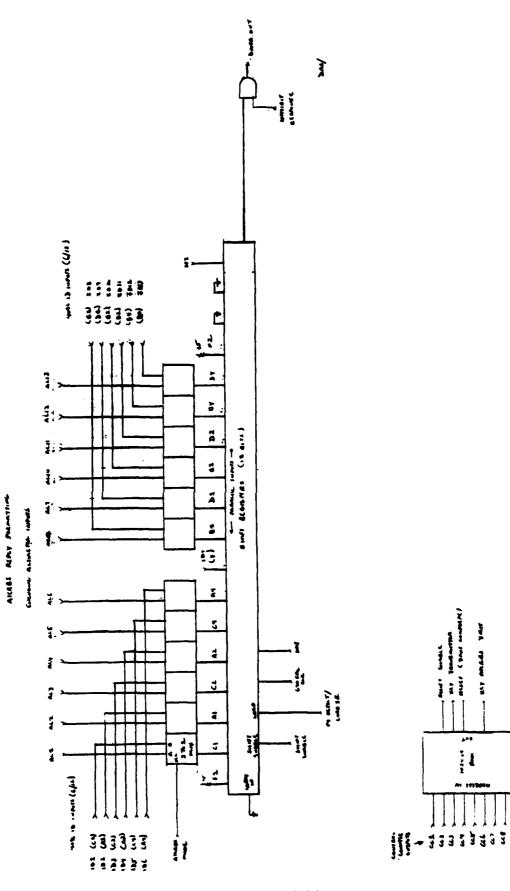


Figure E-8. ATCRBS REPLY FORMATTING

įį

1.8 Squitter Emission

The squitter is an unoslicited reply. It is transmitted at an average of once per second for the benefit of BCAS surveillance by an airborne interrogator.

Squitters are emitted at random intervals with a mean value of one second and a standard deviation of 0.1 to 0.2 seconds. To accomplish the pseudorandom behavior of the events, a ROM is employed which contains a list of 256 intervals of time, which when executed in sequence, meet the criteria of the DABS standard. An eight-bit counter is utilized as the pointer in the list.

The interval of time specified by the eight bits is loaded into another counter which is then enabled such that it counts up to the maximum value. At this point, a carry takes place which sets a flip-flop, generating a request to transmit a squitter.

The squitter is sent unless it has been delayed due to the following controls:

- 1) an identical response (DF4) was sent within the past second
- 2) PC = 2 or PC = 3, indicating a lockout to squitters for the next 16 seconds
- 3) a message is already being formatted for transmission
- 4) mutual suppression (other equipment is being used)

Squitters immediately resume, following the interrupt condition. Each time the control logic cycles through a squitter transmission, it increments the counter which selects the next interval in the ROM and the timing begins again. Figure E-9 illustrates squitter generation.

1.9 DABS Parity Check/Generation

This logic, shown in Figure E-10, generates the Cyclic Redundancy Code used as the 24-bit parity code in DABS messages. This generated code is used to check the parity in uplink messages and to generate it for downlink messages sent by the transponder.

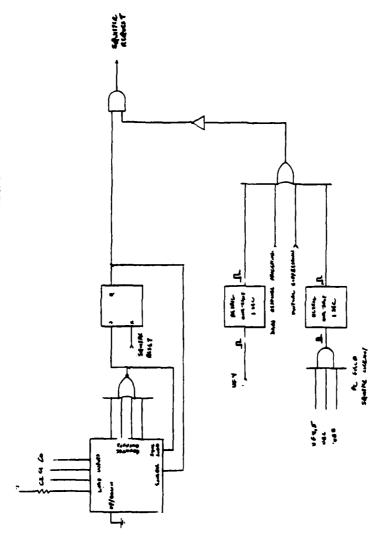


Figure E-9. SQUITTER GENERATION

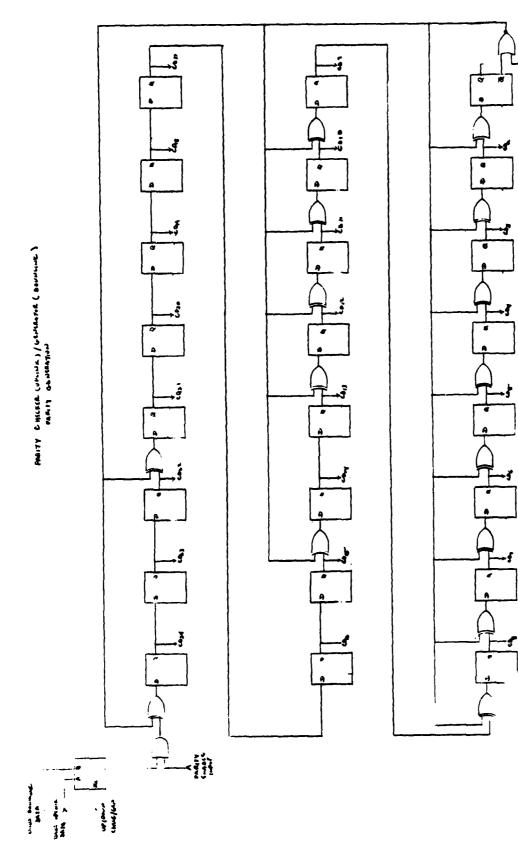


Figure E-10. PARITY CHECKER (UPLINK)/GENERATOR (DOWNLINK)

Thirty-two bits of data appear as serial input. Using the generator polynomial (as described in the DABS Standard, Section 4.1.1.1, page 25), a 24-bit remainder is created. This remainder (parity) is overlaid with further data.

In checking the parity on uplink messages, there are two cases to consider. If the uplink interrogation is UF11; a DABS-only All-Call, then no modification is made to the generated parity bits; a DABS-only All-Call contains no overlaid discrete address because it addresses all aircraft. Therefore, the generated parity bits are left untouched. If the uplink interrogation is other than an UF11, a DABS-only All-Call, the discrete 24-bit address associated with the aircraft is overlaid on the generated parity bits, module 2, on a bit-by-bit basis, as shown in Figure E-11.

In the case of a downlink message, the routine functions to generate the 24-parity bits based on the newly assembled 32-bit message. If the reply is to an uplink interrogation other than an All-Call, then the discrete 24-bit address is overlaid on the generated parity bits as before. If the reply is to a DABS All-Call interrogation, then the 4-bit II (Interrogator Identification) field found in the uplink interrogation is overlaid (added bit-by-bit, module 2) to the most significant bits of the generated parity bits. If the reply is to an ATCRBS/DABS All-Call, then, since no Interrogator Identifier is specified, it is overlaid onto the generated parity bits. However, since adding 24 bits of data which are all zeros, produces no change, the parity bits are left unmodified and processing is complete.

1.10 Stochastic Acquisition (Probability of Reply)

This logic utilizes a randomizing scheme to limit the replies of aircraft.

The probability of reply limiting takes place only when the appropriate code is transmitted during a DABS All-Call message (UFl1), and replies according to the probability unless an All-Call lockout is in effect. When a DABS All-Call is received, the three least significant bits of the PR field (Uplink Bits UB6-8) determine the probability of reply. A free-running 4-bit counter has outputs which are decoded to produce four signal lines (D_0-D_3) . During the course of a count cycle (0-15), D_0 is high one-

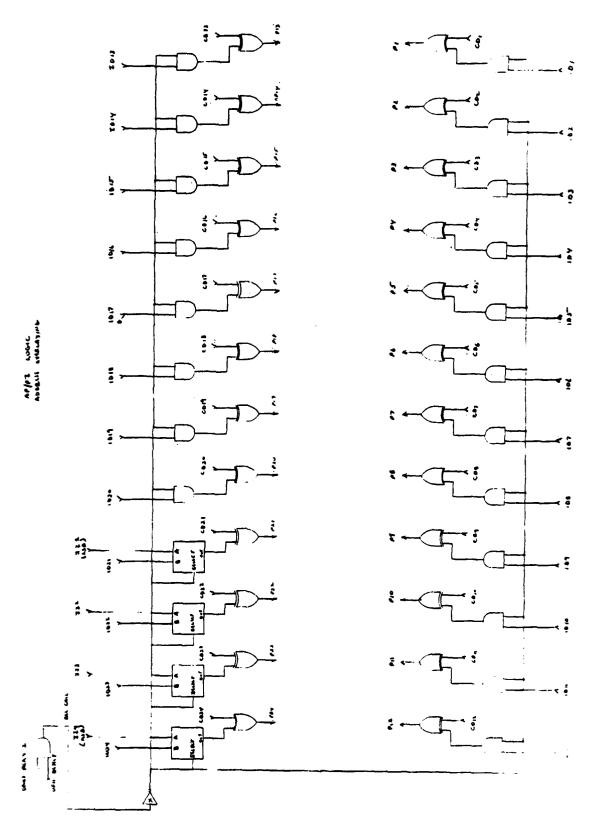


Figure E-11. AP OR PI FIELD ADDRESS OVERLAYING LOGIC

half the cycle, D_1 is high one-fourth the cycle, and D_2 and D_3 are high one eighth and one sixteenth of the cycle, respectively. The coding of the PR field selects one of five lines which determine whether a reply will be made. If PR = 0 or PR = 8, then a reply is made. If any of the other four lines is selected, it is added with the corresponding D line; if both lines are high, a reply is made. If not, the system is reset. The probability of reply logic for stochastic acquisition is shown in Figure E-12.

1.11 Data Field Definitions

The Alert data field logic triggers a 16-second timer whenever a change occurs in the 4096 code. On each clock pulse a 12-bit register stores the 4096 code. A 12-bit identity comparator compares the present 4096 code with the value stored in the register. If a difference is detected (e.g., when a change has been detected between clock pulses), then a pulse is sent to a 16-second one-shot circuit. The output entitled "Temp Alert" is fed to the circuitry which implements the flight status (FS) field. The "Alert" circuitry is shown in Figure E-13.

The FS data field logic illustrated in Figure E-14 sets a 3-bit code according to a prioritized list of conditions. If the circuit is airborne with no ALERT and no SPI the FS code is set to zero. FS equal to one is BCAS related and not part of the baseline system. With an ALERT condition, FS is set to two. If only the IDENT push button was pushed (SPI) the FS data field is set to six if both the ALERT condition is set (4096 code equals 7500, 7600, 7700 or other wise changed) and the pilot has pushed the IDENT push button within the last 16 seconds. If the circuit is on the ground with no ALERT and no SPI, FS is set to seven. FS equal to three or five are not assigned.

1.12 DABS Reply Formatting

The basic system must respond to five DABS message types: Short Special Surveillance (BCAS), Short Synchronous Surveillance, All-Call, Altitude, and Identity. This logic acts to select the proper data for incorporation into the downlink message. The first five bits are echoed from the interroga-

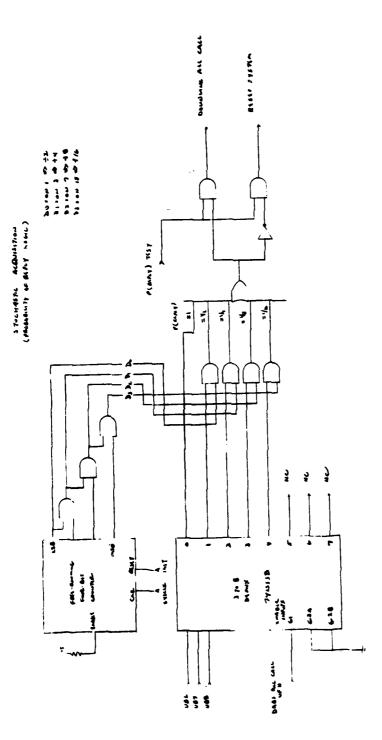


Figure E-12. STOCHASTIC ACQUISITION

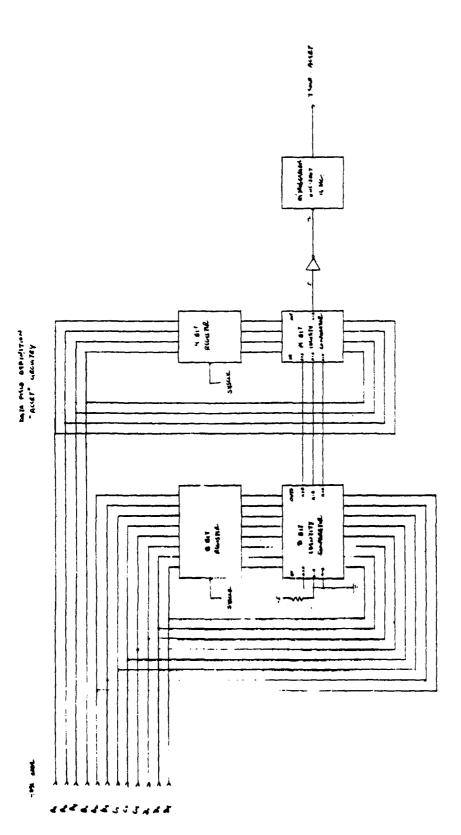


Figure E-13. DATA FIELD DEFINITION "ALERT" CIRCUITRY

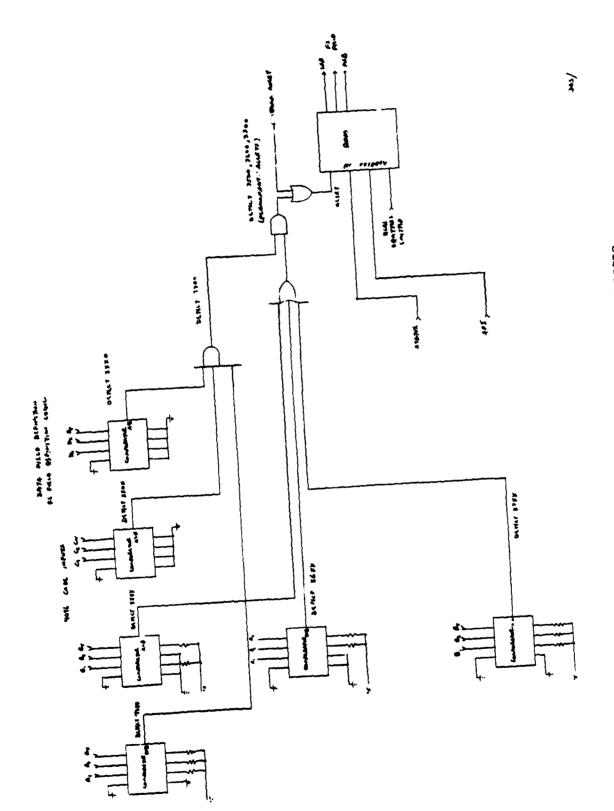


Figure E-14. DATA FIELD DEFINITION LOGIC

tion. These specify the format number. The next 27 bits are formatted by DABS reply logic. The remaining 24 bits are parity bits generated by other circuitry.

If the reply is a Short Special Surveillance Interrogation (UFO), then a reply is formatted echoing the Acquisition bit (Uplink Bit 6) from the interrogation, the maximum airspeed (3 bits from the back panel connector), and the aircraft altitude; all other data bits are zero. If the reply is to a Short Synchronous Surveillance Interrogation (UF2), then the 8-bit Epoch field is echoed in the reply with the aircraft altitude; all other data bits are zero. This design does not reflect the length of the Epoch field as defined in the current DABS National Standard.

If the reply is to an All-Call Interrogation, (UF11) then the logic selects two fields of data. The capability field (CA, 3 bits) is obtained from the back panel connector. The aircraft discrete address (AA, 24 bits) is also obtained from a back panel connector. This complete the 27 bit message.

If the reply is to an Altitude or Identify message (UF4 or UF5), then four data fields are selected. The flight status field (FS, 3 bits) is determined from additional logic not described here. The downlink request field (DR, 5 bits) and the utility message field (UM, 6 bits) are not utilized in this system and are set to zero. The fourth field is 13 bits in length and either aircraft altitude (AC obtained from the encoding altimeter) for an altitude interrogation (UF4) or aircraft ID (the 4096 code set by the pilot) for an ID interrogation (UF5). The DABS reply control logic is shown in Figure E-15, with the DABS reply formatting illustrated in Figure E-16 and E-17.

1.13 All-Call Lockout

The lockout circuitry shown in Figure 18 consists of three major sections:

1) the logic which sets the 15 timers which are associated with the 15 possible interrogators; 2) the logic which sets the standard All-Gall Lockout timer; and 3) the logic which tests the conditions and generates an inhibit pulse (if necessary) to prevent a reply.

193

?

3

45

13

海海温

4 595

100

United Follows METATOWN CARREL

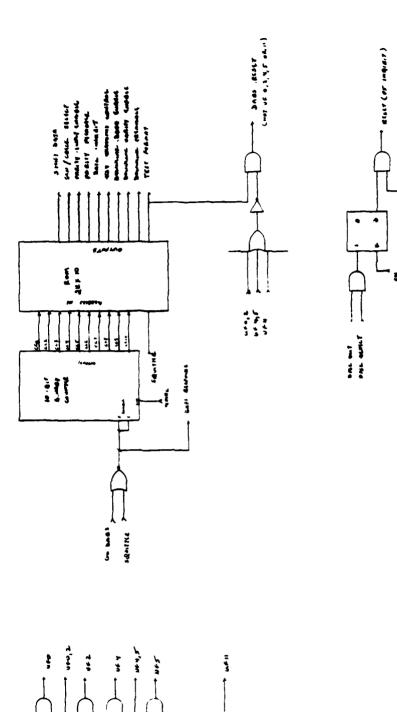


Figure E-15. DABS REPLY CONTROL LOGIC

S A

12 15

15 4 15 4 3

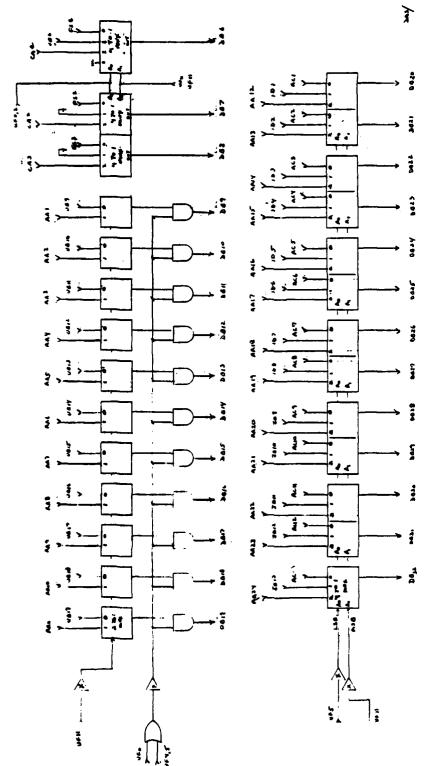


Figure E-16. DABS REPLY FORMATTING

Figure E-17. DABS REPLY FORMATTING

ŝ

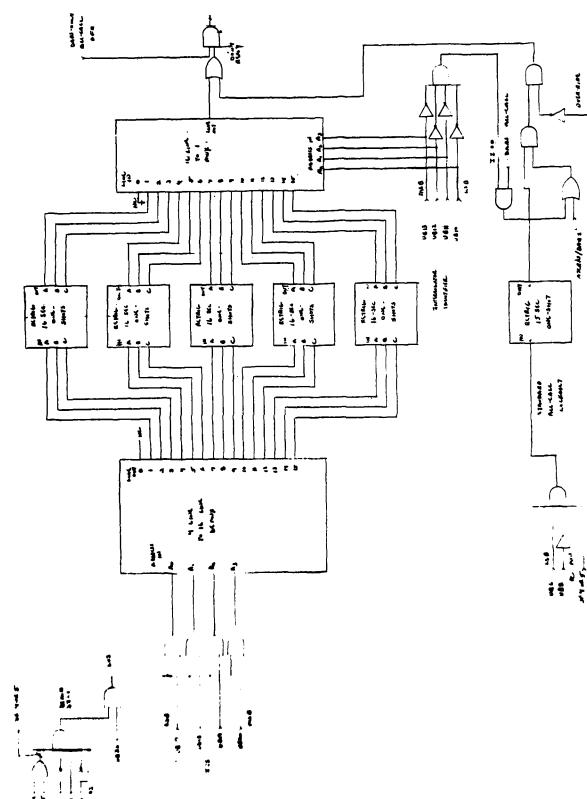


Figure E-18. LOCKOUT LOGIC

1580

The timer setting logic operates as follows: in an uplink message 4 or 5 (UF4 or UF5), the condition of DI (UB14-16) indicates the contents of SD (UB17-32). Should DI equal one, then UB26, LOS contained in the SD field indicates the status of a restricted All-Call Lockout. If LOS equal one, the timer corresponding to the interrogator specified by UB17-20 (IIS) is set. IIS equal zero is a no-action operation. The timer which is triggered has a time-out value of 16 seconds unless retriggered. All 16 timers function independently.

The Standard All-Call Lockout timer can be set by the occurance of an uplink message 4 or 5 (UF4 or UF5), as well. If the message occurs and UB8 equal one and UB8 equal zero (corresponding to PC equal 1 or 3), then the 16-second Standard All-Call Lockout timer is set. It may also be retriggered.

The testing logic consists of two parts. The first tests the Restricted All-Call Lockout condition. If an All-Call is received with II not equal to zero, the timer designated by II is checked; if its output is high, a "Don't Reply" pulse is generated, inhibiting a reply. If II equal zero, then a "Don't Reply" pulse is generated, if D the standard All-Call Lockout timer is set and 2) the override signal (UB9 in the PC field) is zero. If the override signal is high, then no Standard All-Call "Don't Reply" pulse is generated. If the standard timer is set and an ATCRBS/DABS interrogation is encountered, a standard lockout condition will exist if no override is present.

1.14 Comm A and Comm B

The additional 56 bits of information transmitted from the ground in a Comm A interrogation are fed directly into a Random-Access Memory (RAM) from the baseline transponder control logic. This process is then supervised by local control logic which sends the 56 bits out of the transponder through a Standard Message Interface (SMI). The SMI consists of three ports: data out, data in, and bi-directional clock port. The local control logic writes the 56 bits received on the SMI into the RAM for later inclusion in the downlink response. This logic functions at the prompting of and in conjunction with the baseline transponder control logic.

The basic Comm A and Comm B logic is illustrated in Figure E-19. The baseline transponder logic and multisite protocol logic were modified as necessary to function with these added features; these modifications are not reflected in the drawing.

2.0 ATARS

2.1 Memory Enabling Logic

The 56 bits of ATARS data are shifted from the baseline transponder logic into seven eight-bit registers, as shown in Figure E-20. The first eight bits contain the Address Definition Subfield (ADS) which indicates the content of the remaining 48 data bits. These bits comprise two fields known as data sets; the ADS specifies the type of data sets which have been transmitted. A 74S138 demultiplexer is used to decode the bits to determine what the two data sets contain. For this implementation, aircraft own data sets and supplementary data sets are not utilized; therefore, messages represented by ADS 24 and 31 (with bit 48 set to zero) do not produce any action. The message represented by ADS 29 (start threat) is also not needed in this unsophisticated implementation.

Depending upon the message received, either or both uplink data sets may contain a position report which must be displayed. Memory elements (Latches) have been allocated to retain this data; 21 bits are assigned for the bottom display line (Data Set A) and 12 bits for the top display (Data Set B). Data loaded into Data Set A latches when a Start or End Encounter message (ADS 26), a Dual Proximity message (ADS 27) or a Threat message (ADS 30) is received. Data loaded into Data Set B latches when an Own Plus Positive message (ADS 25), a Dual Proximity message (ADS27) or a Single Proximity message (ADS 28) is received. The baseline transponder logic generates a Message Received pulse when the bits have been loaded into the shift registers in the proper position; this pulse enables the latches to copy and retain the uplink data. The message received pulse is also delayed by one clock period (1 microsecond) so that the 16-second non-retriggerable one-shot circuits can be activated. These circuits disable the latches so that a new message cannot replace the data from the last message until the 16-second time-out period has elapsed.

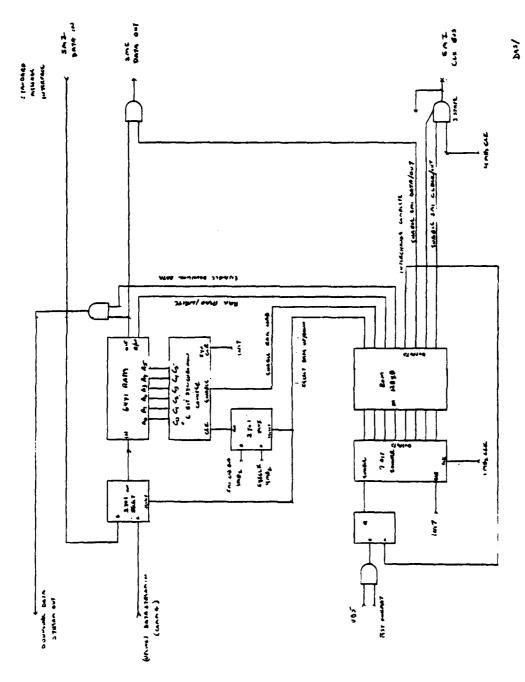
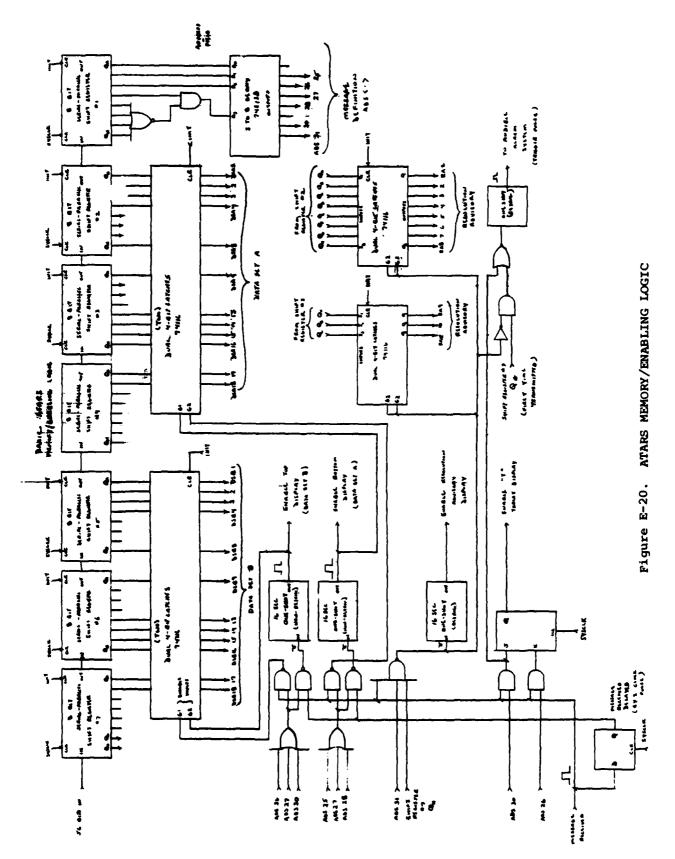


Figure E-19. COMM A/COMM B STANDARD MESSAGE INTERFACE



The state of the s

E-34

A third set of latches for Resolution Advisories retains the 11 bits of data used for decoding and display. When a Resolution Advisory message (ADS 31 coupled with bit 48 set to one) is received, the data is loaded immediately into the latches. This 16-second timer enables the display logic, but does not lockout the latches as in the case of Data Set A and Data Set B. This circuitry generates the control signals for the remaining logic. As previously mentioned, the timers enable the two Data Sets and Resolution displays. A red "T" is illuminated when a threat condition occurs. A flip-flop is set by a threat message (ADS 30) and cleared by a Start or End Encounter Message (ADS 26). Also an audible alarm (external to the transponder) is triggered when the first threat message (ADS 30) or a Resolution Advisory Message is received.

2.2 Advisory Display

When enabled, this logic, as illustrated in Figure E-21, decodes the eight bits corresponding to the eight possible advisories on this transponder (limit vertical commands were not used). These bits are decoded into signals which control the arrows and "X"s. Hex buffer chips (7417s) are utilized to drive the Light-Emitting Diodes (LEDs). An "X" is constructed using four LEDs; the arrows use three.

2.3 Bearing Display

The bearing display logic is illustrated in Figure E-22. The enable command (either Enable Button Display or Enable Top Display) controls the blanking input on the 7446A BCD-to-seven segment driver. Four bits of data are extracted to drive a ROM which creates a two-digit display indicating the clock bearing of the aircraft in proximity. The clock bearings that can be displayed are 1 through 12.

2.4 CO/HI/LO Display

The enable command for this display, illustrated in Figure E-23, allows the two altitude bits to be decoded into one of three messages: CO (co-altitude), HI (the proximate aircraft is above) and LO (the proximate aircraft is below). Seven-segment LEDs are used to display the characters. The 7417 drivers are implemented to drive the individual segments to spell the desired word.

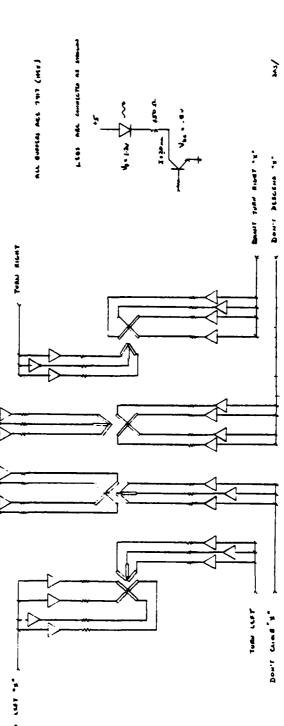


Figure E-21. ATARS ADVISORY DISPLAY

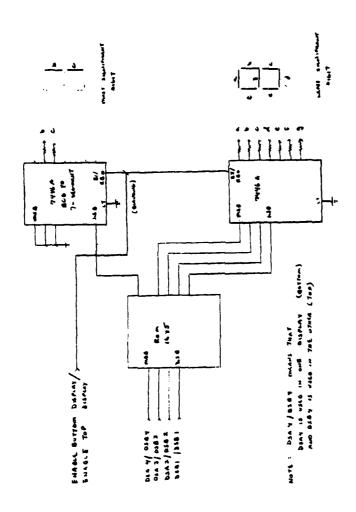


Figure E-22. ATARS BEARING DISPLAY (ONLY ONE SHOWN)

}

Figure E-23. ATARS ALTITUDE DISPLAY (ONLY ONE SHOWN)

Ş

2.5 Range Display

The enable command controls the 7446A drivers such that they display range in two digits (with decimal point in between). The six bits of range data are decoded by a ROM which provides eight bits of data to the drivers which control two 7-segment LEDs. The ATARS range display logic is shown in Figure E-24.

2.6 "T" Threat Display

When enabled, a "T" is displayed for a threatening aircraft. This "T" flashes at a lHz rate to indicate to the pilot that a proximate aircraft is a threat and that a Resolution Advisory could take place. An audible alarm is signaled by a one-shot circuit in conjunction with this display so that the pilot is alerted to this change in status of a proximate aircraft. Figure E-25 shows the logic circuit for the threat display.

2.7 BCAS Interface and Resolution Advisory Register (RAR)

The ATARS design also includes a RAR capability and an interface to an on-board BCAS unit. Upon receipt of each ATARS uplink message, the eleven resolution advisory bits are stored in latches as well as in shift registers. The latches drive the ATARS display. As shown in Figure E-26 the on-board BCAS unit may request the eleven bits from the shift registers by generating a load signal (LOAD RAR DATA) and supplying the clock pulses (BCAS CLOCK). This request procedure, however, may be interrupted by an uplink message. Whenever an uplink message is received, it is given priority, since the data cannot be repeated without retransmission. Should the registers be loaded with new resolution advisory data from an uplink message while the previous data was being shifted to the BCAS unit, the BCAS unit is notified by the receipt of an UPLINK BCAS MESSAGE RECEIVED signal and BCAS reinitiates the procedure.

BCAS may modify the resolution advisory bits driving the display by taking advantage of the structure of the ATARS message decoding logic.

BCAS generates a 56 bit message (BCAS DATA OUTPUT) which is directed into the seven ATARS shift registers through the 56 BITS IN port. When all data is in the proper location, then BCAS generates a pulse (RAR MESSAGE SEND) to the ATARS logic (as a MESSAGE RECEIVED pulse) which loads all of

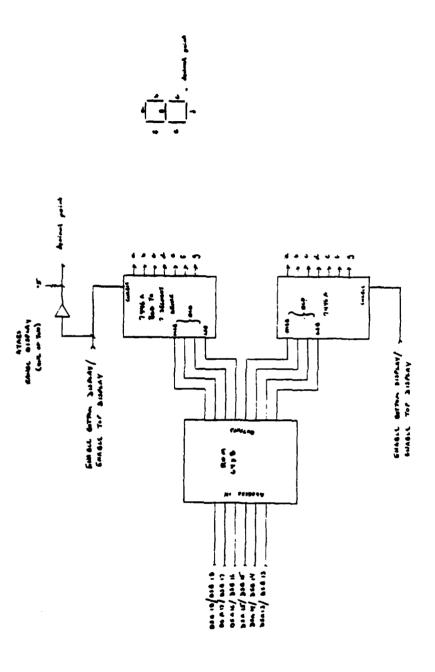


Figure E-24. ATARS RANGE DISPLAY (ONLY ONE SHOWN)

2 2

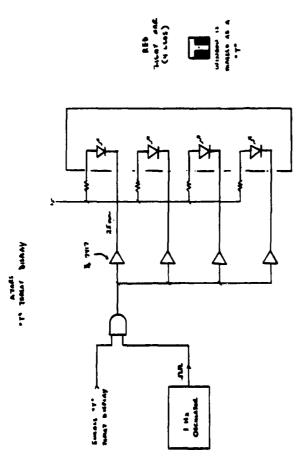
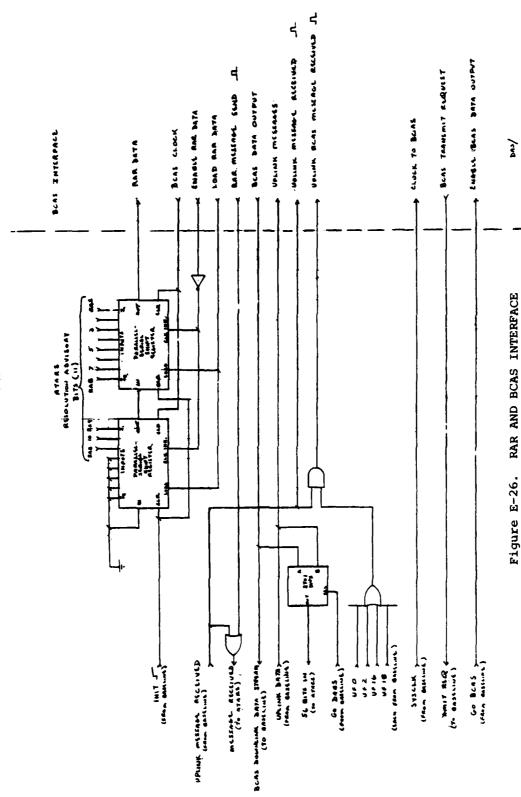


Figure E-25. ATARS "T" THREAT DISPLAY (ONLY ONE SHOWN)



the resolution advisory bits in the appropriate registers in the same manner as the receipt of an uplink message. This procedure may also be interrupted by an uplink message. Should the ATARS shift registers be receiving BCAS data when an uplink message occurs, the BCAS unit is notified by the receipt of an UPLINK BCAS MESSAGE RECEIVED signal as before and BCAS may also reinitiate this procedure at some later time.

For the on-board BCAS unit to generate an air-to-air interrogation utilizing the DABS transponder, a request is sent (BCAS TRANSMIT REQUEST) to the baseline transponder logic which responds to BCAS with a confirmation of the start of the transmission sequence (ENABLE BCAS DATA OUTPUT). The contents of the message from BCAS are then shifted out (according to the transponder system clock) for inclusion in the downlink data message initially formatted by the baseline transponder logic.

All uplink messages received by the DABS transponder which have been correctly addressed and properly decoded are sent to BCAS (UPLINK MESSAGES). A pulse (UPLINK MESSAGE RECEIVED) indicates the arrival of each message for timing purposes. The receipt of uplink messages containing BCAS data are also indicated by a pulse (UPLINK BCAS MESSAGE RECEIVED).

3.0 EXTENDED LENGTH MESSAGES (ELM)

3.1 ELM (Uplink Only)

The central component in this design, as illustrated in Figure E-27, is an 8048 microcomputer which acts as the process controller. It interfaces to the baseline transponder logic and provides the liaison with the 2Kxl Random Access Memory (RAM) (used for storage of the ELM segments) and the External Data Device (EDD) which buffers the segments to the data terminal. The microcomputer performs both housekeeping functions and functions necessary for the proper receipt of the ELM segments.

While the microcomputer cannot process data at a 4-megabit/second rate, it can act as a controller for a RAM which can handle the data rate. When the microcomputer is advised of the impending receipt of an ELM segment by the baseline transponder logic, it determines the upper four address bits of the

Figure E-27. ELM UPLINK ONLY

2Kxl RAM such that the 80-bit segment is stored in one of sixteen 128-bit vectors. The selection of the least-significant seven address bits is accomplished by an eight-bit counter which is enabled by the microcomputer and a control signal from the baseline transponder (message received). The clocking is accomplished by the 4 MHz system clock from the baseline transponder control logic with the microcomputer selecting the proper clock input for the counter.

As each ELM segment is received, it is written into the 2Kxl RAM. The microcomputer maintains a table correlating where each of the received ELM segments is stored; this table is then consulted when the segments must be extracted in order. The table also contains the basic data which is incorporated in the downlink reply which is prompted by the receipt of the (presumed) last ELM segment; this reply is formatted in a 128xl RAM under microcomputer control. This basic data is included in the downlink response by the transponder logic which then controls the RAM through the TRANSMIT response which drives the binary counter driving the RAM.

When all segments have been received correctly, the microcomputer interacts with the external data device, which communicates to the microcomputer that it is prepared to receive the ELM segments. The microcomputer then transmits the ELM segments in order at a high data rate which presently has not been specified.

3.2 ELM Uplink and Downlink

As in the uplink-only version, the control component is a microcomputer which acts as a process controller. It interfaces to the baseline transponder logic and provides the liaison with both of the 2Kxl RAMs used for storage of the ELM segments and the External Data Device (EDD) which buffers the segments. The ELM Uplink and Downlink is shown in Figure E-28.

The 8039 microcomputer utilized in this design is faster in speed than the 8048 (minimum cycle time of 1.36µsec as compared with 2.5µsecs). The 8039 depends upon the 8355 peripheral chip to provide the 2Kx8 ROM containing the instructions; the peripheral chip also provides two additional eight-bit data ports for input and output. The additional capability is necessary because of the added responsibilities the system must assume in order to handle the downlink ELM segments.

Figure E-28. ELM UPLINK/DOWNLINK

The 8039 microcomputer performs all of the tasks associated with the ELM downlink design. In addition, it interacts with the EDD to obtain the ELM segments destined for downlink transmission. The EDD obtains the raw data and converts it into a number (maximum of sixteen) of segments; it then notifies the microcomputer that it has a number of segments available for transmission. At a free time, the microcomputer instructs the EDD to send a segment; this is written into a 2Kxl RAM. This process continues until all segments are written into the RAM. The EDD writes additional information into the RAM which informs the microcomputer of the number of segments to be transmitted. Upon completion, the microcomputer interacts with the baseline transponder to formulate the downlink transmissions. Necessary data is written in the 128xl RAM which is dumped as part of the downlink message.

The ELM Uplink/Downlink system has two principle functions: uplink and downlink ELM interaction. The uplink system has priority, since the data must be handed over as it arrives and the microcomputer must be ready when it occurs. The interaction with the EDD for the transmission of uplink segments and the receipt of segments destined for downlink transmission are handled by the microcomputer when it is idle (i.e., not receiving uplink segments). This system relies on the EDD, 1) to receive and transmit ELM segments at a high data rate and 2) to buffer the data to and from the terminal or other data input/output device.

As in the uplink, the microcomputer allows data to be written into the 2Kxl RAM with minimal overhead. The microcomputer selects a RAM vector where the next segment will be stored. A counter is then enabled such that the presence of a clock from the EDD will drive the counter and generate the addresses necessary to write the data into the RAM.